Phys

INSTRUMENTS and AUTOMATION

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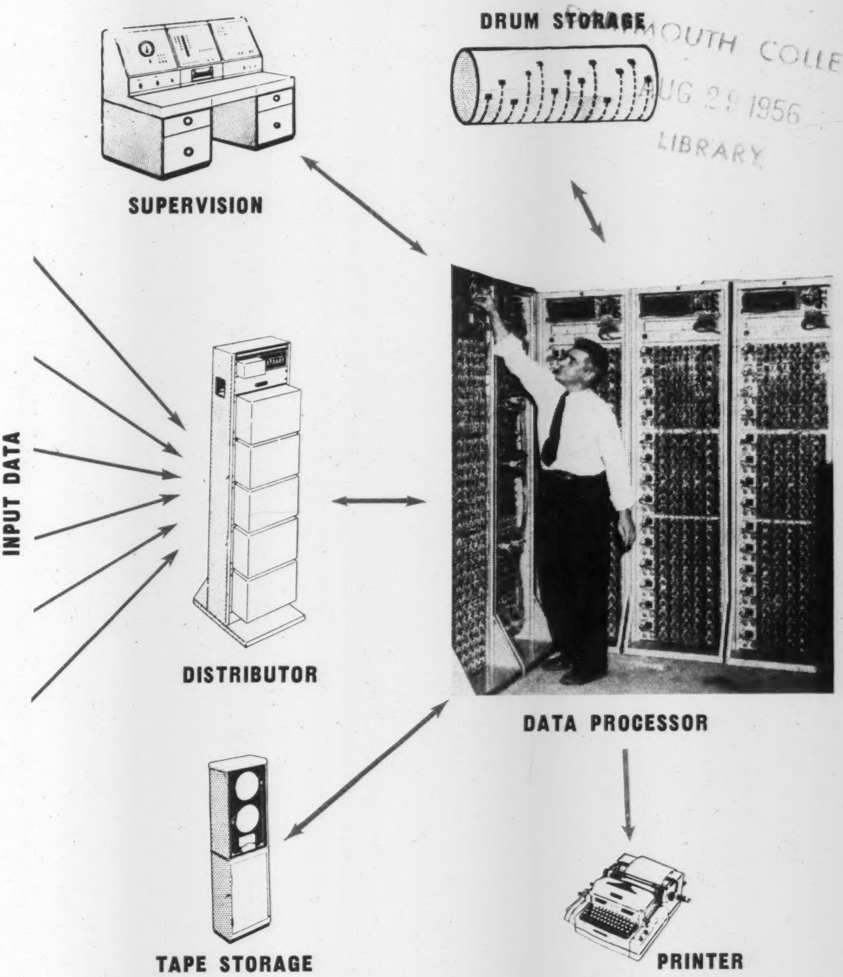

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MAGNETRONIC DATA HANDLING . . . page 1536

AUGUST 1956

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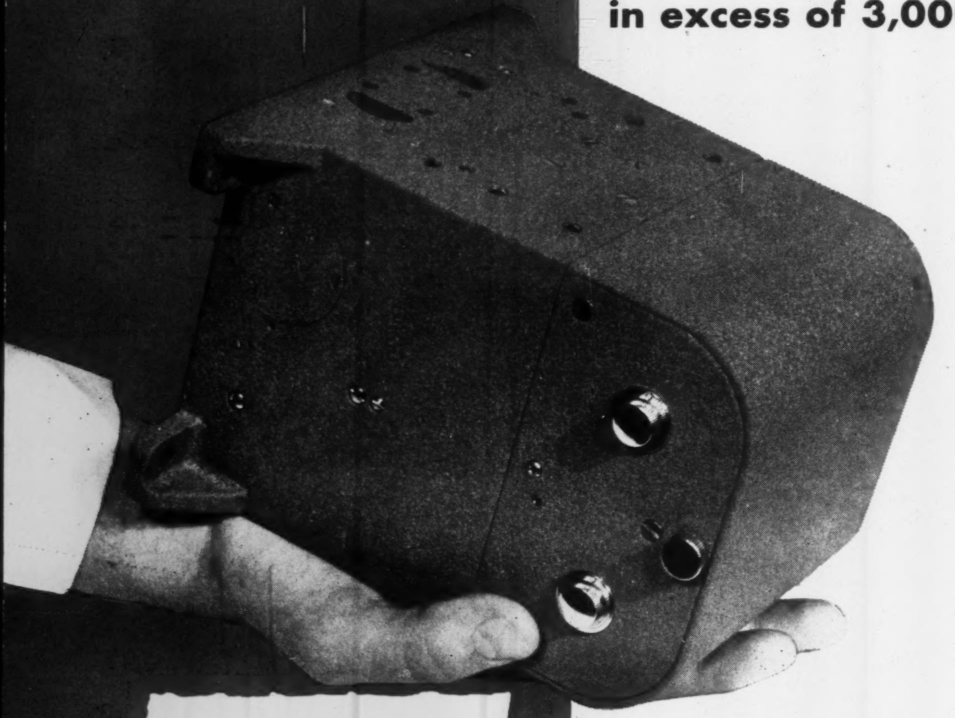

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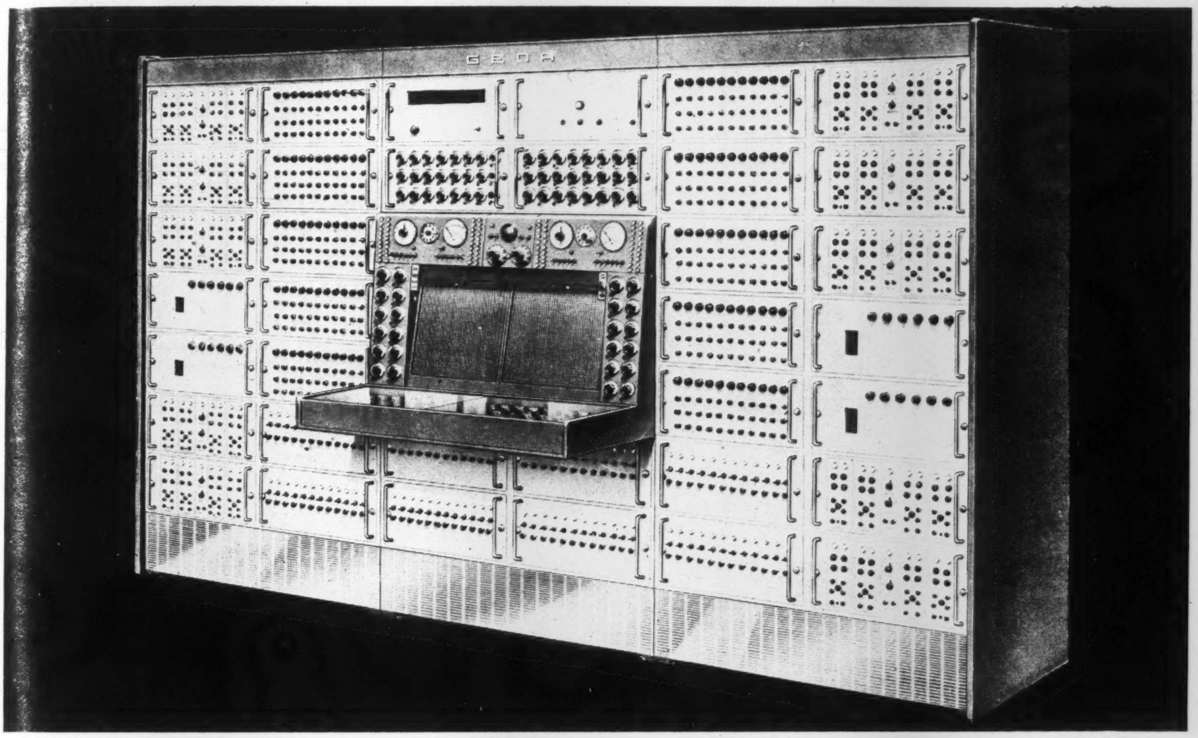

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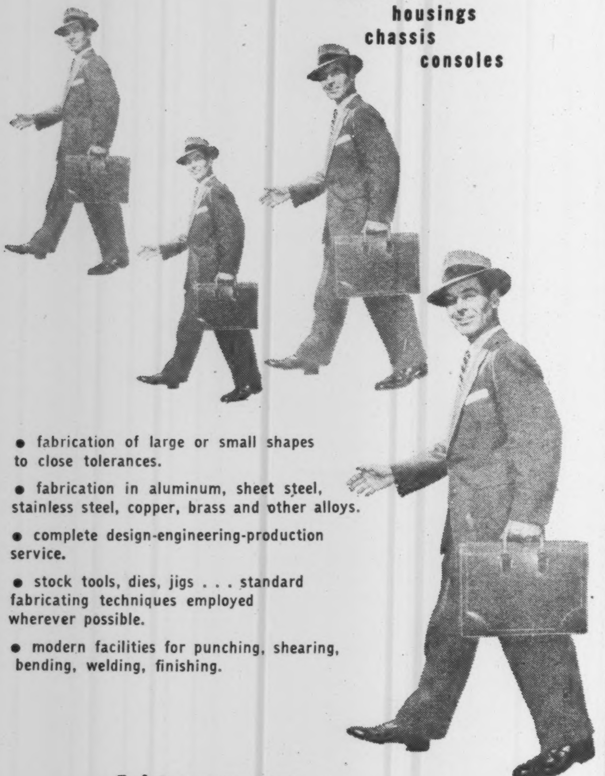

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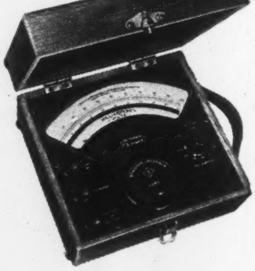

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August 1956

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL FOR 28 YEARS — SINCE JANUARY 1928

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INSTRUMENTS and AUTOMATION

Letters to the editor

Editor, I&A:

My purpose in writing is twofold. First, I would like to compliment your staff on their fine selection of articles which appear in *Instruments & Automation*. I find that the majority of the articles are technical enough in detail to be of use to the Systems or Automation Engineer. The articles cover a well-diversified field to provide stimulation of thought in this large growing field. My only complaint is that copies of your publication are difficult to obtain in our office library, and this, of course, is not your problem.

Secondly, I would like to request several reprints of the article published in Volume 28, No. 4 of the April, 1955 issue of *Instruments & Automation* entitled "Industrial Uses of Analog Computers".

Armand G. Mueller
Systems Engineer
Industrial Controller Div.,
Square D Co.
Milwaukee 12, Wisc.

Your reprints are on the way, Armand. This important article, plus the 5 other computer-clinic sessions of the First Automation Exposition, are available also in the COMPUTER HANDBOOK, First Edition.

Editor, I&A:

Thank you for publishing my letter to the editor in your May issue.

However, I think you will find if you will re-read my letter, that a very important point was overlooked when not included as part of the over-all discussion, and so failed to point out the most important feature of the P-K valve.

I refer to the part of my letter in which I point out that Mr. Beard was incorrect in stating that a Venturi section body design was impractical for proportional control purposes due to the difficulty of designing control characteristics into such a design.

The P-K valve, in addition to almost twice the capacity of conventional control valves, less unbalance force (by 60 to 75%) than conventional single-seated control valves, ability to handle extremely high pressure drops due to its low unbalance forces, and still provide bubble tight shut-off, has an essentially linear flow characteristic with rangeability in excess of 100 to 1.

This linear flow characteristic and high rangeability is the control characteristic which Mr. Beard stated was "precluded" or too difficult to design into a Venturi section body.

I hope you don't mind my bringing these facts to your readers' attention and trust you can see why the points on flow characteristics and rangeability are important to this discussion. Further, I'm sure you personally will find these claims to be of value in light of the amount of editorial on control valves that you publish in *Instruments and Automation.*

H. L. Paul, Jr.
P-K Industries, Inc.
North Arlington, N. J.

Editor, I&A:

Your May 1956 issue of *Instruments and Automation* credited an item on page 840 entitled "Program Control," to the National Bureau of Standards *Technical News Bulletin.* This, as you undoubtedly know by this time, is an error.

William R. Tilley, Chief
Office of Technical Information
National Bureau of Standards
Washington 25, D. C.

The mistake is ours. This hot little item was a technical note in the Review of Scientific Instruments, Vol. 26, 1955, page 1077.

Editor, I&A:

In the May issue of *Instruments & Automation* on page 890, there is an article entitled "Process Data Logging Systems" by Robert J. Marmorstone of Panellit, Inc., which I enjoyed reading until I reached page 894. Figure 8 shows two data loggers used on an aircraft testing program with an analog-to-digital conversion system built by Consolidated Electrodynamics for Convair. However, much to my surprise, in the acknowledgements at the bottom of the page, figures 8 and 9 were accredited to Minneapolis-Honeywell Regulator Co. Incidentally, this same photograph appeared in one of our Systems Division ads which we ran in an earlier issue of your own magazine.

In the June issue of *Instruments & Automation* there is an article entitled "Process Applications of Analytical Instruments" by Herbert Simon of The Fluor Corporation, which has rather glaring errors also. On page 1144, in the section on Mass Spectroscopy, I somewhat disagree with his statement "One failing of the mass spec is that it cannot distinguish between isotopes, as for example: n-butane and iso-butane." For several years we have been building one particular mass spectrometer which is entitled "an isotope ratio mass spectrometer" and it is designed primarily for the purpose of distinguishing between isotopes. Even our large analytical instruments can do this to a certain extent. As for the examples given, both n-butane and iso-butane are not isotopes but isomers.

Also, under section C—Refractometer—the figure 3 is a Consolidated-Philips differential refractometer, which has been the designated name for a year-and-a-half now and has appeared as such in a couple of the ads in both of your magazines.

George H. West
Public Relations
Consolidated Electrodynamics Corp.

Regarding the Marmorstone article, the pictures of the CEC equipment were submitted to us by Arthur Freilich of Minneapolis-Honeywell (they were a part of a paper Arthur delivered at the last Texas A&M Symposium, a nice example of friendly cooperation). Thus the acknowledgement. Of course all our readers know that CEC is now the source for the Phillips refractometer—oops, I mean the Consolidated-Phillips differential refractometer. As for the isomer-isotope item, the author apparently meant to say "isomers" (atoms or nuclides of the same mass number but different energy levels) rather than "isotopes" (atoms or nuclides having the same number of protons in their nuclei but differing in the number of neutrons and hence in mass number).

Editor, I&A:

The article (Control Valves, Part 4, by C. S. Beard) contains many outright misstatements.

To give you some examples, we have:

1. Face to face dimensions of flanged valves have *not* been stan-

Continued on page 1443

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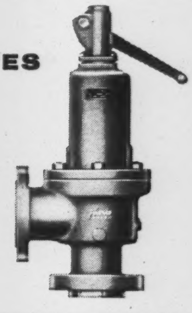

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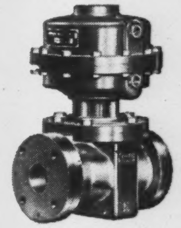

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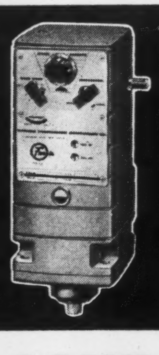

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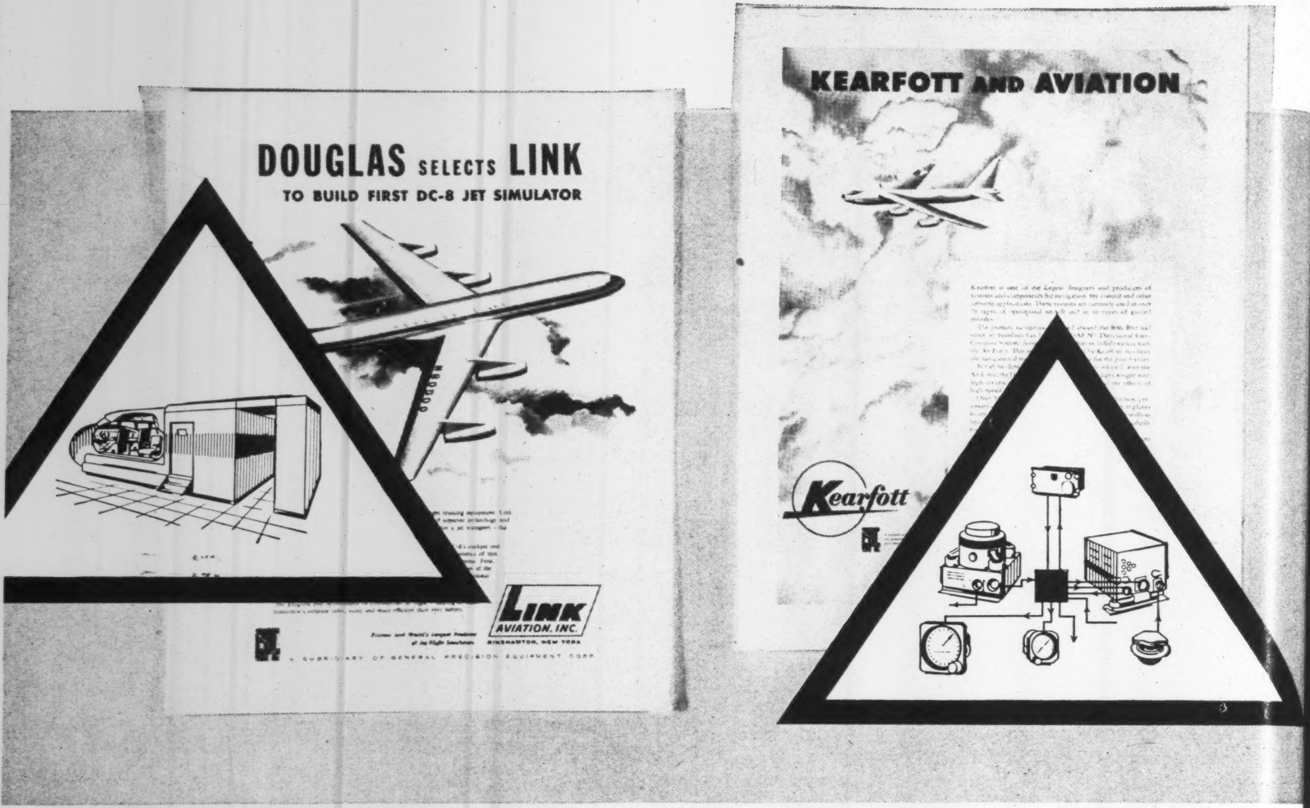

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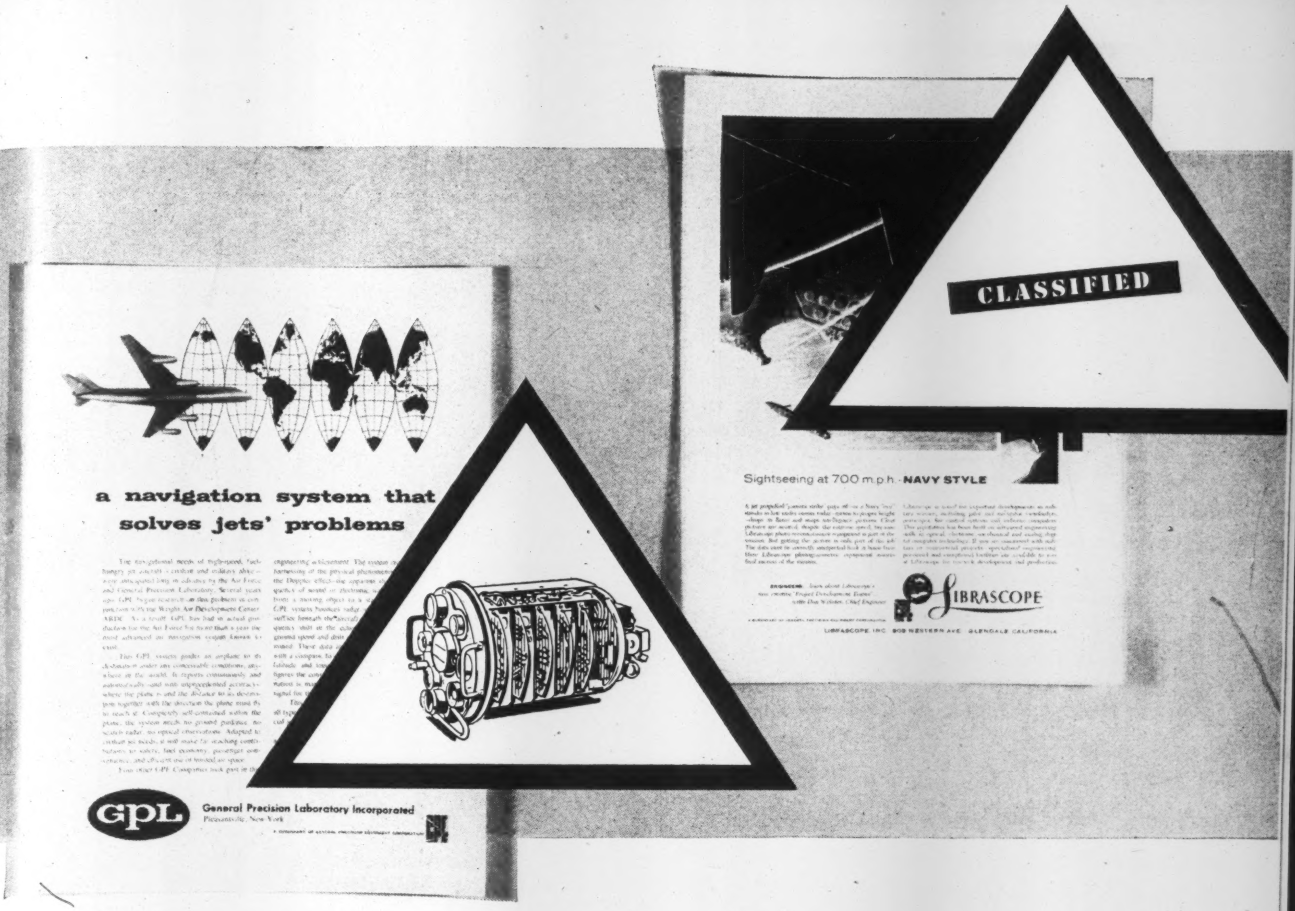

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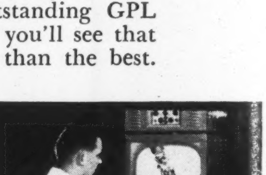

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ardized to be the same as line valves.

2. The correct name of the sponsoring organization is the National Steam Specialty Club, rather it was, since the association is now known as The Fluid Controls Institute, Inc.

3. The use of weld end valves while on the increase is far more prevalent in steam plant installations than in high pressure gas metering stations.

4. Even the statement on screwed end valves is too general. For example, many companies use flanged end valves on all services and particularly on the chemical services whether or not unusual temperature or high pressure conditions exist.

5. Ring joint and tongue and groove flanges are installed at the discretion of the user and not necessarily on elevated temperatures and pressures only. Actually tongue and groove flanges are very rare. Ring joint flanges are often used on applications where the line fluid is ambient temperature.

6. Stainless steel (18-8) plugs and seat rings are virtually an industry wide standard for control valves other than low pressure valves used for building heating, etc. Brass trim *might be* used on a cheap water reducing regulator. It is virtually impossible to combine every kind of direct pilot operated regulator in a discussion of control valves.

7. The use of integral seats or seal welded seat rings is not based on the problem of external vibration. We have never sold valves with this modified construction for this reason. The reason generally is the possibility of erosion or erosion-corrosion behind the rings and the most common usage is on high pressure steam service.

8. Figure 4-6 is a highly special construction not particularly suitable for such a general article.

9. Figure 4-7 shows the very special double seated, soft seated construction which fits in the gas valve shown in Figure 4-4. There is little point in showing such a rarity. We doubt that the average reader can figure it out.

10. To be of value, the section on soft seated designs should be generalized and include mention of the use of some of the high temperature materials, controlled compression seating, etc.

1. While we have taken the time to dictate quite a number of detailed comments on this particular article, we want to re-emphasize that a general layout and basic idea of com-

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West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

For more information circle 8 on inquiry card.

To the truly creative man— no greater challenge

Men who are interested in the long-range planning of new data processing systems are invited to discuss an exciting future at IBM.

IBM is now studying the future requirements of industry, government and science for the handling of information. Systems engineers are needed to analyze these requirements and to create new systems, concepts and plans. Experience in the computer field is not essential; experience with systems other than data processing may qualify you for this work.

Examples of such experience are: communications networks, guided missile systems, automatic control systems, business methods and controls. The essential features of the kind of experience that will qualify you are the knowledge of a variety of types of equipment and ability to evaluate various solutions to systems problems.

The task of designing integrated systems of humans and machines to achieve still more effective results from complex data processing offers opportunities for spectacular achievements in the next few years—with rewards commensurate with the importance of the project.

For further details write to W. M. Hoyt, International Business Machines Corporation, Room 3628 , 590 Madison Ave., N. Y. 22, N. Y.

Plants and Laboratories at Endicott, Poughkeepsie, Owego and Kingston, N. Y., and San Jose, Calif.

IBM INTERNATIONAL BUSINESS MACHINES CORPORATION

DATA PROCESSING • ELECTRIC TYPEWRITERS
TIME EQUIPMENT • MILITARY PRODUCTS

LETTERS—CONTINUED

bining valves and regulators under the heading "Control Valves" hopelessly complicates the picture. There is a real need for some basic information on control valves which summarizes the constructional features in a practical manner. Such a series, however, will require a great deal more careful study and arrangement than is evidenced in this series.

P. Wing, Jr.
Mason-Neilan
Div. of Worthington Corp.
Norwood, Mass.

Our old friend Paul Wing is entirely correct in objections 1 and 2; as line valves are not standardized, control valves cannot conform to line valves. The author wants to debate all the other points, so that these are not open-and-shut issues. Who asked us if *all* our "Letters to the Editor" are complimentary?

Editor, I&A:

How can I obtain the electrical characteristics of some foreign tubes which are in an instrument? I need this information for the design of an auxiliary type of instrument.

Leroy Walkow
Pittsburgh 6, Pa.

The Electronic Tube Section, National Bureau of Standards, Washington 25, D. C. will service your request. Data on 10,000 tube types are available, with about 1000 arranged for mechanical sorting via punched cards. The files include the products of about 15 foreign manufacturers and 80 domestic manufacturers.

Editor, I&A:

You are correct in your statement (each month, in the "Electronic Circuitry" feature) that the circuit is the heart of all electronics. There is an unfortunate tendency among teachers and advanced physicists that the circuit is unimportant compared with the principle of equation involved. Unfortunately, the principle and the equation usually follow the development of the circuit, and only rarely can a circuit be designed from an equation. For example, take the Bertram multivibrator shown on page 85 of Instruments and Automation for January 1956. I defy anyone to show me an equation for a positive grid multivibrator which shows that frequency is the linear function of grid voltage. One of the reasons why transistors are not more widely applied is that manufacturers and publishers, in general, are not presenting enough transistor application notes showing circuit, constants, and boundaries of operation.

I suggest that you keep your section on "Electronic Circuitry" in its present form, perhaps expanding it to four pages, and then add a somewhat similar section called "Transistor Application Notes."

J. N. A. Hawkins
Byron Jackson Division
Borg-Warner Corporatio
Los Angeles, California

As you have discovered, there is indeed a great amount of practical electronics in our feature "Electronic Circuitry." Rather than add a separate section on transistor circuitry, we are including basic transistor circuits in these articles. You will see many good transistor circuits in future columns in the "Electronic Circuitry" series.

Editor, I&A:

I am enclosing a copy of a letter that I have been sending in large numbers to manufacturers of data processing equipment. I have made considerable use of your magazine, particularly the *Catalog and Index* of July 1955 for which I am grateful.

J. W. Greenwood
Data Processing Committee
Atomic Energy of Canda Limited
Chalk River, Ontario

Atomic Energy of Canada has set up a committee to study the application of modern developments in data recording and processing to the needs of a large research laboratory. They found the I&A Catalog & Index helpful in reaching manufacturers of digital printers and typewriters, tape punches, binary-to-decimal converters, graphical display equipment, analog-to-digital converters, and any product that might find application in the general field of data reduction.

Editor, I&A:

We have recently received your letter answering our request for information pertaining to the measurement of specific gravity by the tuning fork method.

Without your assistance and cooperation, I doubt if we would ever have learned the name of the manufacturer of the instrument.*

Thank you very much for your very kind attention to our problem.

R. W. Matthies
General Communication Co.
Boston 15, Mass.

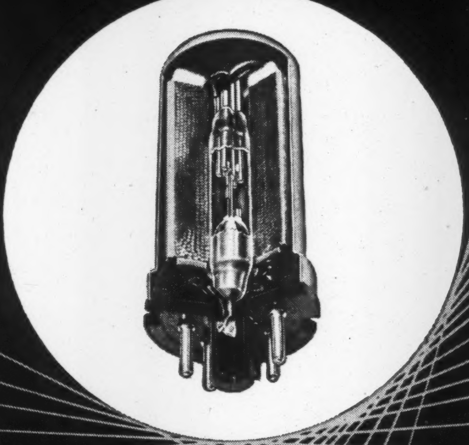
---

*Poole Instrument Co., Dallas, Texas

It can cost you much more to settle for less than this Clare relay

This ad was all but written
by a Clare customer.
Here is the story as he told it:

"I shopped around for relays for continuous-duty, high-speed switching service. Clare engineers recommended Type HG Mercury-Wetted Contact Relays. They said they were ideal for this application. I thought so, too; but they do cost a little more than some other relays, and I thought I couldn't afford to use them. I thought the extra cost, multiplied by the large number of relays in my machine, would run my price too high. So I built a model with cheaper relays. In just a few weeks the relays wore out. I knew that Clare Type HG relays would last for years under the same conditions, and it didn't take me long then to decide that *I couldn't afford not to use them.*"



Ask yourself whether you, too, don't have jobs for which no other relay is good enough. Consider that the life of a Clare Mercury-Wetted Contact Relay is measured in billions of maintenance-free operations. Compare the cost per flawless operation with that of other relays: this is the crux of the matter—a vital, basic point.

The price is very reasonable, and delivery is quick—one to seven weeks, depending on the particular assembly desired and the size of the order.

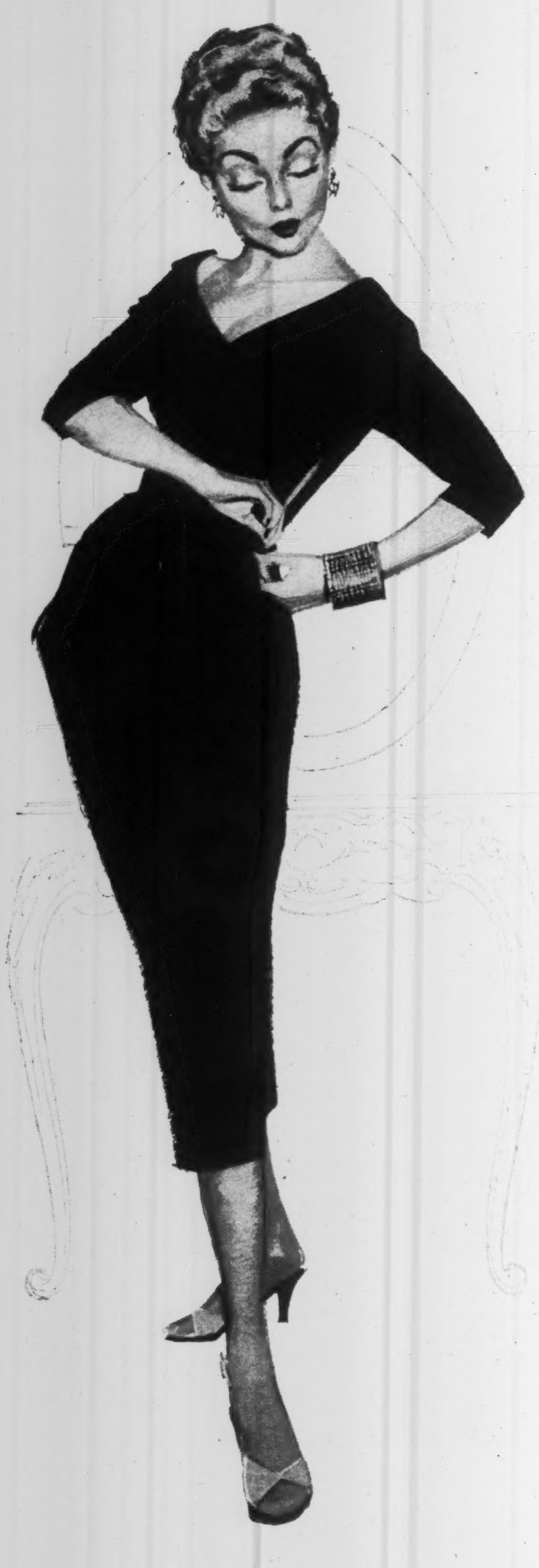
FOR COMPLETE INFORMATION on CLARE Mercury-Wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare & Co., 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.

Send for CLARE Sales Engineering Bulletins Nos. 120 and 122

CLARE RELAYS

FIRST in the industrial field

For more information circle **9** on inquiry card.



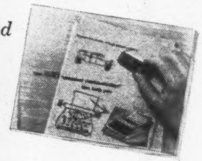
Is size a problem with you, too?

ELGIN can miniaturize and mass produce your assemblies

There's bigger profit in smaller products these days! When conserving space is vital (as in time and control devices, small actuators and other electro-mechanical devices) call on Elgin for creative engineering and specialized assembly facilities. Elgin's broad experience and skill can help you in the design of miniaturized components and in putting them into mass assembly on a low-cost basis. We will work with you on all phases of your miniaturization program.

READ HOW ELGIN'S "PRACTICAL MINIATURIZATION" CAN HELP YOU NOW

This booklet will open your eyes to new opportunities and profits through Elgin's "Practical Miniaturization". It tells how Elgin has helped others . . . how Elgin can help you. Write today for the "Miniaturization" booklet.



ELGIN NATIONAL WATCH COMPANY

MICRONICS DIVISION • ELGIN, ILLINOIS

For more information circle **10** on inquiry card.

INSTRUMENTS and AUTOMATION Inquiries

These inquiries, representing problems facing readers of **Instruments & Automation**, are published as a free service to our readers.

Metal Detector

Agent in large paper company is seeking manufacturers of devices for detecting metal objects on persons passing a certain point. A-117

Nuclear Level and Thickness Gages

Supervisor in city educational department wishes to contact manufacturers of radioisotope type level and thickness gages for use as data for doctor's thesis. A-118

Liquid Level Transmitter

Project Engineer in chemical company seeks liquid level transmitter of the inductance type which has no probe or follower in the liquid being measured. A-119

Brilliance of Solids, and Odor of Liquids

Chemical director in oil processing company seeks instruments to measure (1) brilliance of solids, and (2) odor of liquids. A-120

Hot Pack Temperature Controller

Doctor in medical college seeks manufacturer of hot pack temperature controller for cold rooms. A-121

Testing Facilities

Test engineer in aircraft company seeks information on testing facilities for vibration, acceleration, and temperature testing for setting up a file on these facilities. Also on fungus, salt-spray, shock, and other methods. A-122

Underground Water Pressure

Consultant on underground water seeks instrument for measuring the static pressure near the inlet of an underground pump that is 1000 ft below the surface. Water will be flowing at high rate while measurement is desired. A-123

Computer School

Reader seeks names of schools that offer courses in computer programming and related subjects. A-124

Ultrasonic Processing

Research engineer seeks ultrasonic equipment to perform operation of getting a salt into suspension or solution. A-125

Tensile Stress Measurement

British exporter seeks manufacturer to equip laboratory with apparatus for measurement of tensile stress by means of brittle coatings. A-126

Pump-Type Tachometers

Motor company design engineer seeks information on pump-type tachometers, specifically speed/pressure characteristics and effect of temperature on readings using different liquid media. A-127

Infrared Equipment

Western manufacturer wishes to contact makers of infrared detectors, sources, and spectrometers; also makers of metal, wood and molded instrument cases. A-128

Pressure Alarm

Government chemist seeks warning device to sound alarm when pressure within metallic vacuum system rises above pre-set point, e.g. 10 mm mercury. Power failure must not interfere with alarm. A-129

Instrument Winterizing

Refinery engineer requests information on instrument winterizing; particularly performance data for electrical heating of instrument piping leads, bodies, and housings to prevent freezing of water and heavy fluids in Class I, Division 2 areas. A-130

Inductance-type Level Transmitter

Instrument manufacturer seeks inductance-type liquid-level transmitter which has no probe unit connected with it, but does have a coil wound around a gage glass, with no follower whatsoever in the liquid being measured. A-131

Product Identification

Foreign subscriber seeks manufacturers of: Barco Capacitor, Shure Microphone Cartridge, University Speaker, ICA Cabinet, Atlas Microphone, MS-252 Transistor Socket, and Cinch Jones 2002 Lug Strip. A-132

Where extreme accuracy and constancy are indicated . . .

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FOILS
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FROM Antimony, Bismuth, Cadmium, Cobalt, Copper, Gold, Iron, Indium, Lead, Palladium, Platinum, Nickel, Silver, Tellurium, Tin TO Zinc

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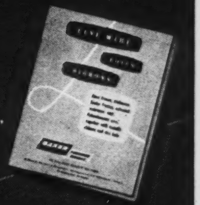

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NEW YORK • CHICAGO
SAN FRANCISCO • LOS ANGELES

ENGELHARD INDUSTRIES

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from –325F
to +3000F

WORLD'S MOST COMPREHENSIVE LINE OF TEMPERATURE INSTRUMENTS

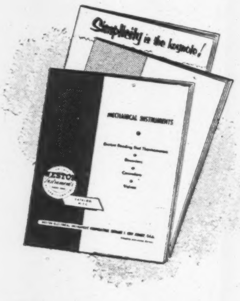
Here's a time-saving, money-saving tip. Whenever you have a temperature problem . . . whether it involves simple, but accurate indications or intricate, sensitive control . . . call on WESTON. From WESTON'S comprehensive instrument line you can readily select . . . *you are sure to get* . . . the temperature instrument exactly suited to your requirement.

For simple indications . . . Weston provides the famous all-metal thermometers — or the filled system types for remote readings — or electrical resistance and thermocouple types.

For recording . . . select from a complete line of filled system recording thermometers — single or multi-point electronic recorders — or, where instrument flexibility is desirable, compact, portable recorders are available.

For control . . . there's a complete line of mechanical instruments — null-balance type instruments — as well as self operating controllers.

So remember . . . whenever you have a problem involving temperature measurement or control, the quickest, the surest solution requires no more than a phone call to your nearest WESTON representative. Literature on request. *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.* A subsidiary of Daystrom, Incorporated.

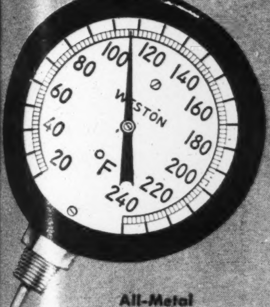


WESTON

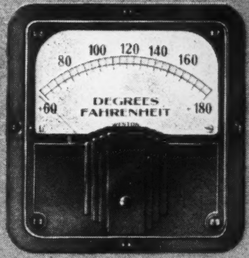
HEADQUARTERS FOR TEMPERATURE

For more information circle **13** on inquiry card.

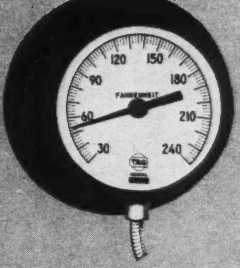
TO INDICATE



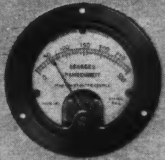
All-Metal THERMOMETERS — industrial and laboratory types



Electrical Resistance THERMOMETERS — also thermocouple types

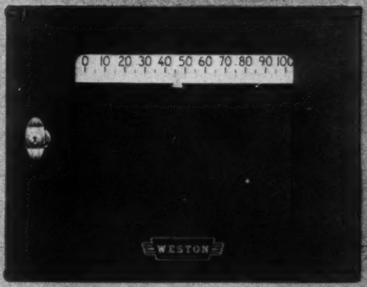


Filled system THERMOMETERS for remote readings

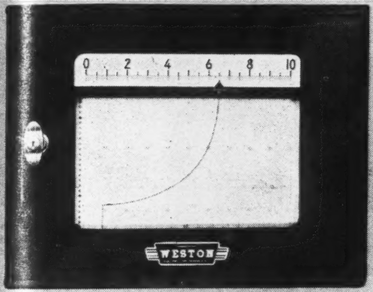


Pyro-Millivoltmeters panel or portable form

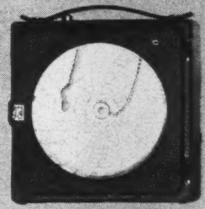
Self-balancing, and manually balanced INDICATORS null balance type



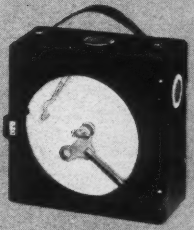
TO RECORD



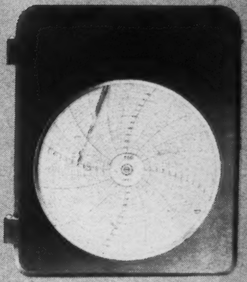
Single and Multi-point RECORDERS null balance type



Miniature Portable RECORDERS filled system type

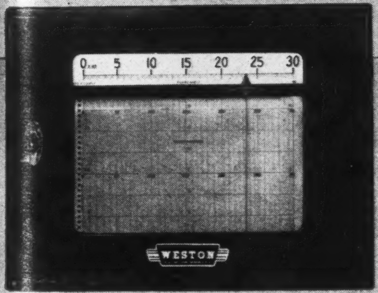


Miniature bi-metal RECORDERS

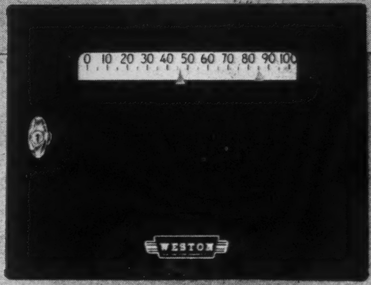


Mechanical RECORDERS

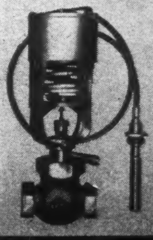
TO CONTROL



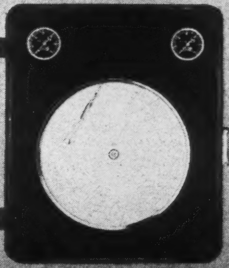
Recording CONTROLLERS null balance type



Indicating CONTROLLERS null balance type



Self operating CONTROLLERS

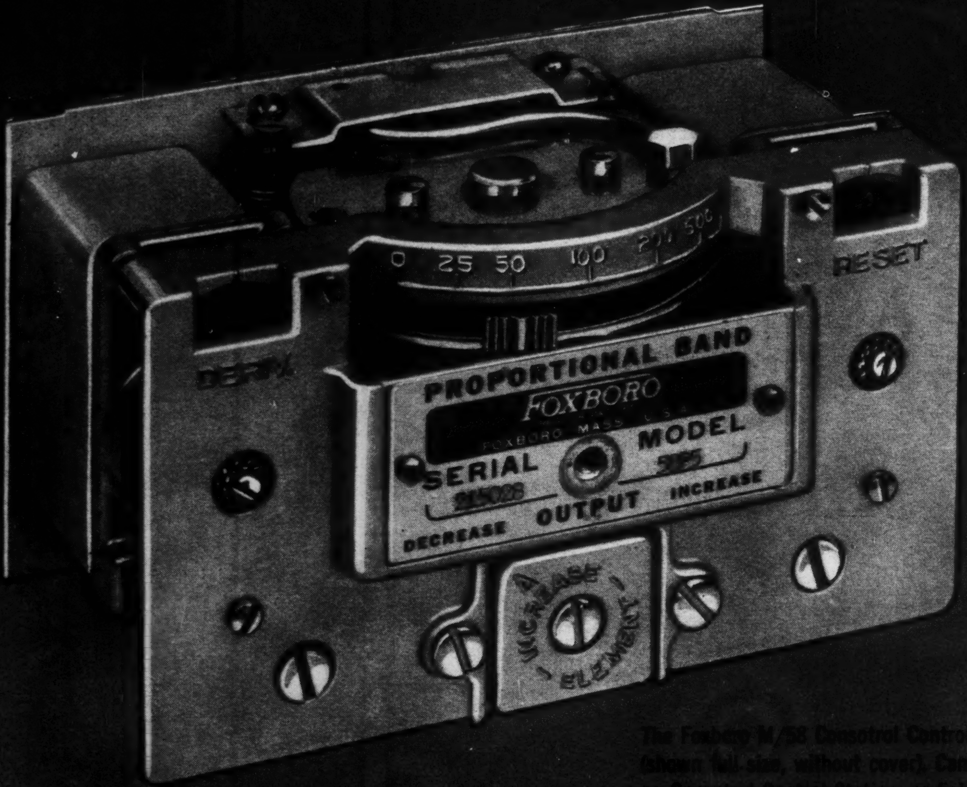


Mechanical CONTROLLERS

Sensitive contact-making RELAYS

INSTRUMENTS TO INDICATE, RECORD, CONTROL

For more information circle 13 on inquiry card.


0 25 50 100 200 500
DERIV.
RESET
PROPORTIONAL BAND
FOXBORO
FOXBORO MASS. U.S.A.
SERIAL
MODEL
DECREASE
OUTPUT
INCREASE
INCREASE
ELEMENT

The Foxboro M/58 Consotrol Controller (shown full size, without cover). Can be panel-mounted on Consotrol Control Station, or field-mounted.

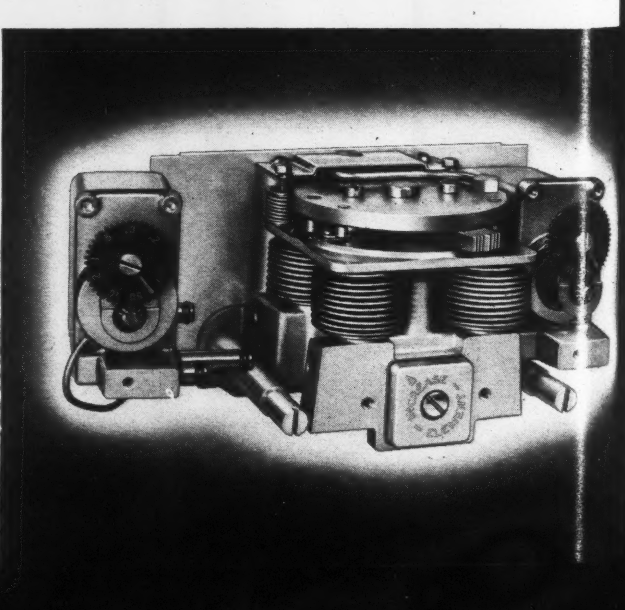
THE FOXBORO M/58 CONSOTROL ...

The M/58 Controller's Revolutionary Floating Disc System →

Here's the exclusive Foxboro design development that gives M/58 Control its unique versatility, precision, and stability. The floating disc and matched bellows assure uniformly high controller sensitivity and pin-point control action, even at widest settings of the proportional band. Lever-set proportional band adjustment is calibrated to 500%.

Component Construction Gives Unrivaled Versatility

Not only is the complete controller easily detachable as a unit, but also, each component is a "plug-in" unit. For example, reset plugs in at right as shown; derivative, similarly, at left. All 4 control actions, with 2 reset ranges, are available and easily adjustable to widest variations in operating conditions. Proportional action from 1 to 500% quickly set by lever.


INCREASE
ELEMENT

Outperforms all other controllers !

...the controller with the FLOATING DISC

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller on your process. The tougher the job, the more it will outperform other controllers! Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this exclusive Foxboro development has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

The M/58 Controller can do the same for your process. The flexibility of its control functions makes it readily adaptable to *all* processing techniques. All four actions are available, with two ranges of reset . . . all are easily adjustable to the most widely varying operating conditions. For example, reset and derivative functions plug in . . . proportional action from 1 to 500% can be quickly set by a lever. And calibration is a simple zero adjustment!

Get full details on this simple, truly "universal" Controller. Write for Bulletin 13-19 and ask your Foxboro Sales Engineer for a demonstration. **The Foxboro Company, 468 Neponset Ave., Foxboro, Mass., U.S.A.**

**Reg. U. S. Pat. Off.*

FOXBORO **CONSOTROL INSTRUMENTS**

Reg. U.S. Pat. Off.

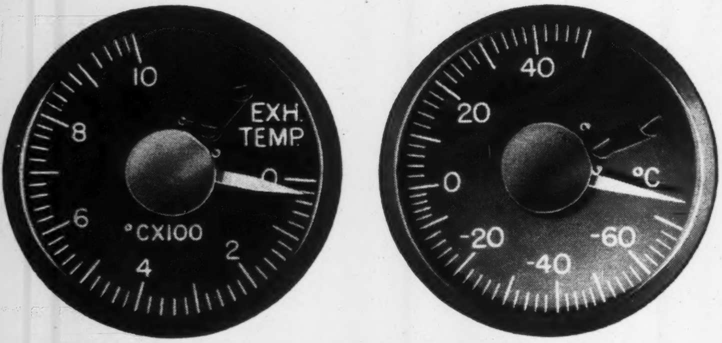
For more information circle **14** on inquiry card.

for improved readability, specify
the new **LEWIS**

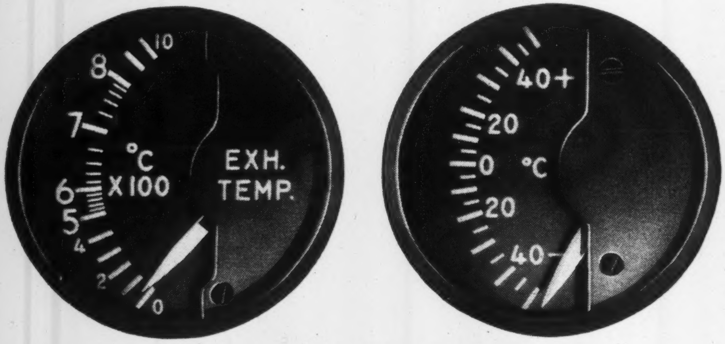
LONG SCALE

aircraft temperature indicators

- Standard AND10412 cases
- Scale arc approximately 250°
- No auxiliary components
- No vacuum tubes
- Operate the same as conventional thermocouple type or resistance type temperature indicators
- Interchangeable with conventional temperature indicators, use standard resistance bulbs or thermocouples and leads
- Made to Military Standard Specifications
- Tested and Approved



COMPARE the improved readability of these long scale indicators with these . . .



Conventional indicators

Recognizing the need for improved readability without increasing panel space requirements, The Lewis Engineering Company has developed these completely new Aircraft Temperature Indicators both in the Thermocouple Thermometer type and in the Resistance Thermometer type.

the LEWIS ENGINEERING COMPANY
naugatuck, connecticut

For more information circle **15** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Single automation device of greatest potential is the analog computer. At the student level it makes mathematics alive to the student and produces a new type of creative engineer to whom math is a living language. At the design level it permits design of components and systems to meet optimum criteria. At the operating level it enables the plant engineer to tell management precisely what benefits can be realized from possible changes in every operational parameter. Already, an aircraft manufacturer who does not use analog computation and simulation is an anachronism. This will be true of process plants within a decade. A place in history awaits the first process plant manager who puts a general-purpose analog computer at the disposal of his engineering staff. Who will it be?

Adult technical education is needed to keep technical workers abreast of rapidly changing technological developments. Increased leisure should be coupled with increased study. Employers should consider trading employees' working time for study time—this would be much more effective than just fewer hours per week labor.

Technological advances are accelerating in frequency as modern "social reactor" builds up efficiency. One result will be change in character of all technical and productive jobs. All workers of future will have more leisure—but will be required to study continuously to keep abreast of changes. Hence adult technical education will be field to watch. In 1935 only one university offered an advanced degree in adult education; in 1955 fourteen universities offered master's or doctor's degrees—with many more offering short courses. Although 30 million adult Americans already participate in adult education, very little has been at technical level. But much will be needed.

Population of USA will increase from present 165 million to 190 million in 1966 to 220 million in 1976. Yet age-group breakdown shows that there will be disproportionate increase in persons over age 65 and under age 20—which means that productivity per available worker must increase 40% within 10 years to maintain our existing rate of change of standard of living. Only increased use of automation will make this possible.

Benefits of increased production efficiency can be of 3 types—increased wages, lower prices, or increased leisure. Present trend emphasizes the first. Guaranteed annual wage could result indirectly in increased leisure.

Electronics industry in USA was born in 1906 with the DeForest vacuum tube. In 1920, annual radio sales were about $2 million. In 1940, sales were $600 million. Today, with 130 million receivers in use, radio market is about $300 million annually, mainly replacement.

Cono-Controls
FOREMOST
IN FINAL CONTROL ELEMENTS

Warren H. Brand, Vice President in Charge of Research and Engineering, shown with members of his engineering staff working on a customer service problem.

CALL CONOFLOW for extra engineering quality

. . . AT A COMPETITIVE PRICE

Practical engineers insist on quality. Therefore, when it comes to final control elements, they insist on Conoflow. The engineering team at Conoflow is second to none in the field. Beyond experience and inventiveness they have an *eagerness* to serve every customer in a friendly and personal way. You get young-company vigor with big-company facilities when you turn your problems over to Conoflow.

Here, too, there are no shortcuts on materials and workmanship. "The best there is" goes into every control valve, power actuator and pneumatic regulator Conoflow turns out. You get top quality at a competitive price.

Insure yourself for quick, dependable follow-through . . . Invest in an *extra* measure of quality and service . . . call Conoflow—today!

VISIT OUR BOOTH
319-A
INSTRUMENT-AUTOMATION SHOW

Sept. 17-21 New York Coliseum
and see . . .

NEW ALL ELECTRIC VALVE ACTUATOR

NEW LTC CONTROL SYSTEM FOR PRECISE POSITIONING OF LARGE CYLINDERS

NEW ELECTRO-PNEUMATIC VALVE POSITIONER

Also Regular Product Line

CC-607

Qualified Representatives in all principal cities

CONOFLOW CORPORATION
SUBSIDIARY OF WALWORTH COMPANY
2100 ARCH STREET • PHILADELPHIA 3, PA.

For more information circle **16** on inquiry card.

Who's Full of Gas Now?

Panhandle Pete

RECENTLY an advertising blurb came through the mails to my home—an advertisement of a radically new industrial-type gas analyzer so advanced in design and fool-proofed in operation that I just have to write something about it. After all, we try to keep the public informed and up-to-date on new instruments, don't we?

Anyhow, this detector is sold and distributed by the Wallace Electronic Service Company of New Somerset, Jefferson County, Ohio under the trade name of "Aves." These detectors come in four models, and the most amazing thing about the Aves are the prices: the cheapest model, The Little Giant, selling at $10.00 and the most expensive model, The Acme, selling at $1500.00. To those of you who are used to paying three times these prices for analyzers I'm sure this is welcome news indeed.

In discussing the operating features of the Aves, it must be kept in mind that the most difficult job must not always be done in the hardest way, and if the description of the instrument sounds ridiculous let me assure you that Mr. John L. (Bus) Wallace, Chief Engineer of the company, has given much of his time and his thoughts to the problem. "Because," as he says, "I spend hours in one of the local steel mills trying to get results with those old-fashioned analyzers and by gawd I'm tired of lugging around all this heavy equipment and trying to keep it running. So I built my own, see, and if . . . ." I had to tap Mr. Wallace behind the ear to shut him up; next to your wife no one likes to talk like an inventor.

In general, all of these analyzers consist of a gas detector cell and a suitable case or stand; the main difference being one of cell quality, i.e., tone, color and size and also instrument case quality. You wouldn't put an expensive canary in a shoe box, would you? Well neither would Mr. Wallace. Unfortunately there are no recorder or controller models on the market as yet, but since the advantages of this present instrument so outweigh the lack of the other equipment I'm sure everyone will want one or two of these around the office just for emergencies.

The accuracy of the Aves is 100%! It does not need to be calibrated against any standard gas and so does not have even one rheostat to fool with—a great advantage when you stop to consider how many "green men" might have to use this instrument. The sensitivity is better than 0.55%, the stability of the instrument in a non-gaseous atmosphere is 100%; the response to approximately 90% of the maximum range is within 8.2 seconds, while the response to permanent reading is 9.0 seconds. The term "permanent reading" means just this. But what's ten bucks for a fool-proof and fail-safe instrument?

The gas analyzer comes in one compact unit, self-insulated and thermostatically controlled over an ambient temperature range of minus 10 to plus 110 degrees F. The chemicals used, H_2O and FE_2D are not corrosive, there is no glass used in the construction and the cell contains its own built-in gas pump which also conditions the gas at the same time; truly a marvelous piece of machinery.

The cell is built in two styles, the M and F. Along with these obvious advantages the assembly connects to no source of power either AC, DC, AM, FM, 75, 60, 45, 33⅓ or BO. The higher priced models, however, are Hi-Fi. There is no simple circuit to follow, no ubiquitous vacuum tube, no transistor, no delicate meters, (I don't suppose there is any computer either?—MHA) (No, there ain't no computer—P P) but only a simple $10.00 cell (Model L.G.) that may last two years and up to the Model A cell which has been known to last fifty years. All this with easy installation and little maintenance. Adapter kits are available for mounting the instrument in a corner, on a panel or over a desk, though we do not recommend the latter position.

To use this analyzer all one has to do is place it in the suspected atmosphere and watch the cell. If it falls over onto its pratt, it is time to get the hell out!

Specifications for Gas Analyzers

Model L. G. (Little Giant)—Consists of a galvanized wire case, simulated marble chemical and H_2O feeder and removeable base. Cell is a Type Passer Domesticus M/F which luckily is found in the United States. Total weight, charged and ready to use, is about two pounds. Immediate delivery. Price—$10.00 F. O. B. New Somerset, Ohio.

Model H.D. (Handy Dandy)—Consists of all of the above features except case is made of 100% virgin copper wire and is 30% larger in volume. The base on this model is tesalated. The cell is a type Sturnas Vulgarus M/F imported from England at great cost. Two weeks delivery. Price—$20.00 F.O.B. New Somerset.

Model D (Dilly)—All of the above features and equipment except case is fabricated from brass and is then guilded. Spring mounted and complete with portable stand. The cell is a Type Harzberg Kanarienvogel, imported on the sly from Germany. (In fact we smuggle them out.) When not in service detecting gas, this model may be used around the shop as an AF Generator. Four Weeks delivery. Price—$30.00 F.O.B. Long Bottom, Ohio (Branch Factory).

Model A (The Acme)—Consists of all the above equipment plus a "Tee" rack, a real honest imported gold chain (Peru) for connecting the cell to the stand and a nickle-plated feeder. All equipment is titivated! The cell is a type Psittacus Erithacus, imported from China. This cell is built with a self-contained P.A. system and, with proper instructions, will soon announce the results of a gas analysis provided the critical point has not been passed. No other instrument on the market will approach the Acme in ease of operation. Delivery—Eight months. Price—$1500.00 P.P.

Note: Fuel for these analyzers may be purchased at your neighborhood drug or department store or may be purchased, in car-load lots, from the W.E.S.Co. Prices on request. Cells may be purchased separately, either M or F. Two cells of appropriate type may be installed in the same case, often with astonishing results. All models can be furnished with suitable dust covers and On/Off switches. For a slight extra fee, disposable base-liners can be furnished for Models D and A.

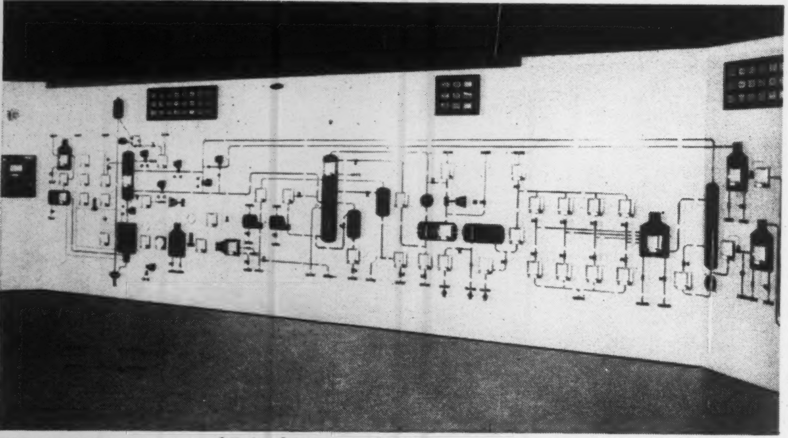
Warning! As a cell in the hand is worth two in the bush due care should be taken in handling the cell for a dropped cell will fly off and vanish in thin air.

For further information write to: Wallace Electronic Service Company, New Somerset, Jefferson Co., Ohio.

Panhandle Pete

BRISTOL'S
INSTRUMENTATION

★ *News and information about automatic controlling, recording and telemetering*



TYPICAL GRAPHIC PANEL of Bristol Metagraphic instruments in oil refinery. Panel designed by The Fluor Corporation and built by Panellit Inc.

New design freedom for systems engineers!

A fully flexible plug-in, functional-unit system, Bristol Metagraphic instrumentation is easiest to plan, install, operate and service

A new concept in automatic control and instrumentation, Bristol's Metagraphic instruments are installed as a three part system with transmitters, receivers, and automatic controllers *completely independent of each other except for connection through a universal 3-15 psi pneumatic signal.*

This functionally designed unit system allows a new degree of freedom from pre-installation decisions by the installing and planning engineers. Changes in instrument layout and control actions can be accomplished in an absolute minimum of time and cost.

Transmitters for every variable

Metagraphic transmitters are available for measuring temperature, flow, liquid level, pressure, absolute pressure, differential pressure and mechanical motion.

The transmitter converts the measurement into a universal 3-15 psi signal, proportional to the measured variable, and sends it to an indicating or recording receiver or an automatic controller.

Calibrated simply in terms of 3-15 psi air pressure; Metagraphic receivers and controllers thus are independent of the actual variable being measured by the transmitter and can be used with equal accuracy to indicate, record or control any of the variables that the different transmitters are capable of measuring.

Metagraphic transmitters are available in a variety of ranges and spans—easily field-adjusted—many with over-range protection to 400%. Their high air output (3cfm) means better recording and control in any application.

Choice of 34 automatic controllers

Bristol Metagraphic controllers are available in 34 different models to suit every need. *Yet almost complete interchangeability between models is possible.*

Full-plug-in construction allows easy change of control mode or service, and practically eliminates down time for maintenance.

Controllers may be receiver-, pipe-, or surface-mounted plug-in type or pipe-connected. Remote or integral set-point types (with or without air loading) are available.

Five modes of control action: On-off, adjustable proportional, adjustable proportional plus reset, fixed proportional plus reset, and proportional plus reset plus derivative (rate).

Quick-change receivers in 35 models

With 35 models to choose from, and full plug-in construction available, Bristol's Metagraphic receivers give you unmatched flexibility in operation.

You can change from a recorder to an indicator or vice versa in 10 seconds. If trouble is suspected, the receiver can be replaced to eliminate down time while it's checked in the shop. There's absolutely no interruption of automatic control since the receiver is outside the control loop.

And . . . check these features:

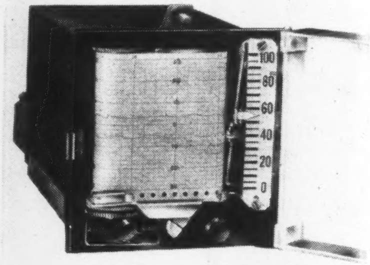
Continuous valve position indication is on same scale as set point. Simply match pointers to achieve "bumpless transfer." No need to read scales.

High-visibility colored fluorescent paints make pointers easy to identify.

Air chart drives are 100% pneumatic (operating from 20 psi supply). No electricity required.

Universal piping manifold can be adapted to any piping system (2-pipe or 4-pipe). No special tools or parts required.

Write for complete data on versatile Bristol Metagraphic instruments for your control, recording or indicating needs.



BRISTOL TWO-PEN metagraphic recording receiver.

Two-pen receiver keeps tabs on four variables

One of the 35 Bristol Metagraphic receiver models available, the two-pen recording receiver records, indicates and controls one measured variable, records one related variable on the same chart and gives a continuous indication of either set point or valve position—whichever is desired.

If valve position is chosen to be continuously indicated, the set point may be indicated at any time by depressing the valve knob. Similarly, if set point is continuously indicated, depressing the knob indicates valve position.

The two-pen recording receiver has the easy readability, compact construction, and plug-in flexibility that characterize all Bristol Metagraphic instruments. It's available with manual-automatic station or six-position transfer valve for cascade control.

Write for complete technical data on this versatile pneumatic recording receiver.

For more information circle **17** on inquiry card.

See what's new at Bristol at the ISA show, New York Coliseum, September 17-21, Booths 1403-1407

NEWS AND NOTES

instruments from Bristol . . . leaders in human-engineered instrumentation

A-subs hot—but under good control

Construction of the hulls for atomic submarines, Nautilus and Seawolf, probably represents the most massive, elaborate, and radically different welding and hull-rolling job ever attempted.

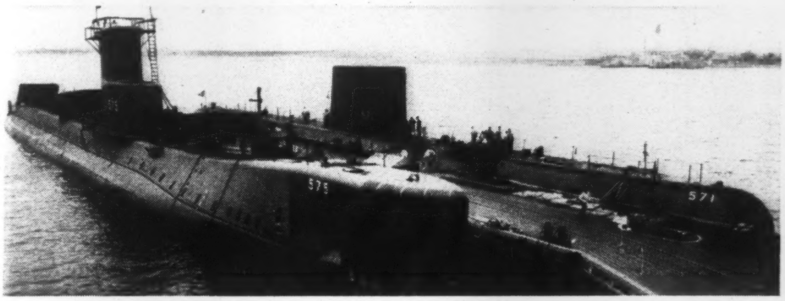
Built by General Dynamics Corporation, Electric Boat Division, Groton, Connecticut, the subs are constructed from short circular sections (like pipe sections). These sections are welded together around their circumference to form the cigar-shaped hull.

Before welding, the area immediately adjacent to the welds is preheated with induction coils wrapped around adjacent ends of the sections to be welded. Bristol Dynamaster pyrometers precisely control the heat produced by these coils.

When preheated to the proper temperature, the sections are "hull-rolled" while stationary welding machines make the weld at constantly controlled temperatures. After welding is completed, the Dynamaster-controlled induction coils maintain the area around the weld at a uniformly decreasing temperature to insure cooling with maximum strength and toughness.

It takes days to complete the preheating, welding, and cooling for a single hull-section pair. Throughout this period the Dynamaster pyrometers keep the hull temperature at the design value, despite widely varying atmospheric conditions.

Want to find out more about Bristol Dynamaster pyrometers for your temperature control job, large or small? Write for Bulletin P1245A.

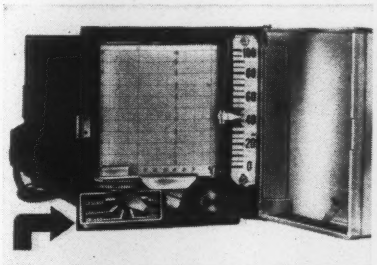


Special receivers simplify cascade control

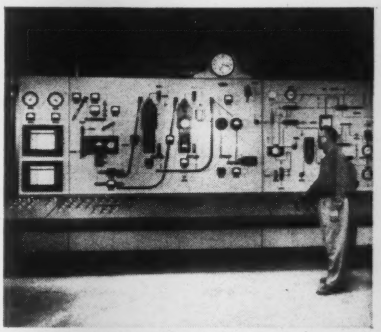
Bristol's Metagraphic receivers for cascade control are offered in a wider variety of models than any similar competitive instrument.

The cascade receiver (or "slave" receiver) is available as a one or two-pen recorder or a one- or two-pointer indicator, or a one-pen, one-pointer model. The two-pen recorder is unique with Bristol. With it, the master controller measurement can be recorded on the same chart as the slave controller record, thus placing both related variables on the same chart. Another, related variable can be recorded in place of the master-controller variable, of course.

One big advantage of Metagraphic cascade control over other similar receivers is the six-position transfer valve, on one knob. Most other models require two knobs, and pointers on two scales in order to achieve bumpless transfer. With Bristol's six-position model you just match pointers *on the same scale*, and switch over.



SIX-POSITION TRANSFER VALVE on one knob for cascade control.



GRAPHIC PANEL at Central Soya Company's plant at Chattanooga, Tennessee.

Bristol instruments help process Soy Beans

Centralized control of a soy-bean oil extraction plant is the function of this graphic instrument panel, installed at the Chattanooga, Tennessee, plant of the Central Soya Company.

Multiple-point Bristol Dynamaster and Metagraphic recorders monitor temperatures and pressures throughout the process, as well as plant power consumption and steam pressure. Ammeters on the panel show current drawn by equipment and conveyor motors. Control switches and running lights are located on the desk surface at front of panel.

One compelling advantage of this graphic panel instrumentation system is that it safely and conveniently shows both management and operating personnel the whole operation. Quality control is greatly facilitated; system upsets may be analyzed and corrected before the final product is affected. This over-all picture is otherwise very difficult to get since the process occupies a building four stories in height that has floor levels made of steel gratings.

OUR ENGINEERS . . .

will be glad to discuss your specific instrumentation or control problem with you. Or, write for complete technical data on any of the instruments mentioned on these pages. The Bristol Company, 111 Bristol Road, Waterbury, Conn.

6.21

WHAT'S NEWS AT BRISTOL . . . WHAT'S NEWS AT BRISTOL . . .

For more information circle **17** on inquiry card.

NOW...

a Transistorized

ELECTRONIC PROCESS CONTROL SYSTEM

'American-Microsen' presents a new all-electronic process control system with...

Transistorized instruments.

All measurement and control functions contained in just three basic units.

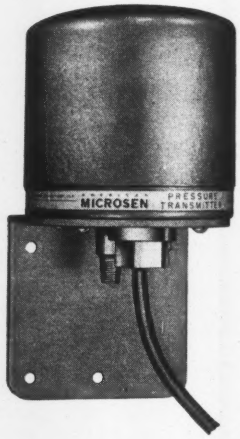
Each unit contained in a single, compact housing.

The *transistorized* electronic Controller has all control room components within one, panel-mounted case. *Transistorized* for highest reliability and compactness, this new instrument saves both panel space and wiring... means better process control for a smaller investment.

For transmission, control and valve operation based on the proved 'American-Microsen' System, be sure to visit:

The I.S.A. Conference and Exhibit
Manning, Maxwell & Moore, Inc.
Booths 404-409
New York Coliseum
September 17-21, 1956

THE TRANSMITTER



The new Series 185 Pressure Transmitter is a miniaturized version of the well-known 'American-Microsen' Pressure Transmitter. It incorporates the latest mechanical and electrical features to achieve maximum operating benefits and usefulness.

The time-tested "Microsen" balance creates a stable dc signal for long distance transmission. Bearing pivots and linkages are entirely eliminated. Consequently, sensitivity is practically infinite, and repeatability of measurement is within 0.001% of range span.

Printed circuitry and miniaturized components reduce the size of the transmitter to only 4⅞" in diameter and 5¼" high. In dust and weatherproof case designed for universal mounting, the Series 185 can be firmly supported on meter piping, pipe pedestal or vertical surface.

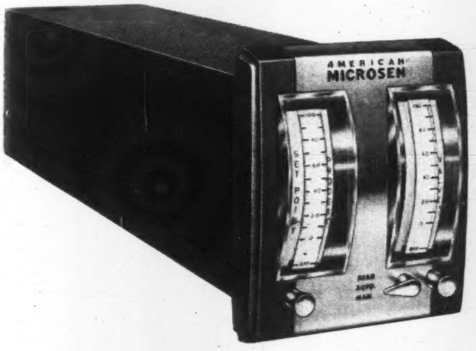
'American-Microsen' Transmitters of similar design are available for differential pressure, flow, temperature and other variables.

MANNING,

MAKERS OF 'AMERICAN-MICROSEN'

For more information circle **18** on inquiry card.

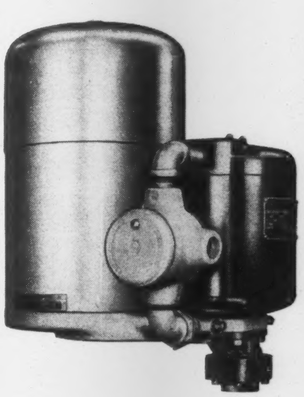
THE CONTROLLER



The Series 164 Controller provides a complete controlling system in a single panel-mounted housing. Now one compact transistorized unit handles *all* control functions: indicating or recording the process variable, controlling, and manual-automatic operation. Transistorized design greatly improves reliability and service life. Savings in panel cost are tremendous because of miniaturization and consolidation of control functions – because no longer is it necessary to wire several units externally.

The Series 164 is available as a Recording Controller, compact Indicating Controller and as a long-scale Indicating Controller. Each functional unit is contained on a separate plug-in chassis within the housing. Each unit can be removed and replaced within moments without disturbing the operation of the other units.

THE OPERATOR



In 1955 we introduced the 'American-Microsen' Electro-Hydraulic Control Valve Operator – a power unit with position feedback to operate control valves, dampers, etc. It completely eliminated the need for compressed air.

More than a year of efficient performance in field service was paralleled by further engineering developments that culminated in the new Series 181 Electro-Hydraulic Control Valve Operator. This improved unit offers simplified design characteristics that mean even lower cost and greater reliability than its predecessor.

The Series 181 Electro-Hydraulic Control Valve Operator is mountable on standard yokes supplied with conventional slip-stem control valves with bodies of single or double-seated construction, with V-port, parabolic, needle and equal-percentage plugs. It can be furnished for all valve sizes, including those of 4″ stroke, and with force available up to 3,250 lbs.

MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION

Stratford, Connecticut

MAXWELL
MANNING M&M & MOORE INC.
TRADE MARK

ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

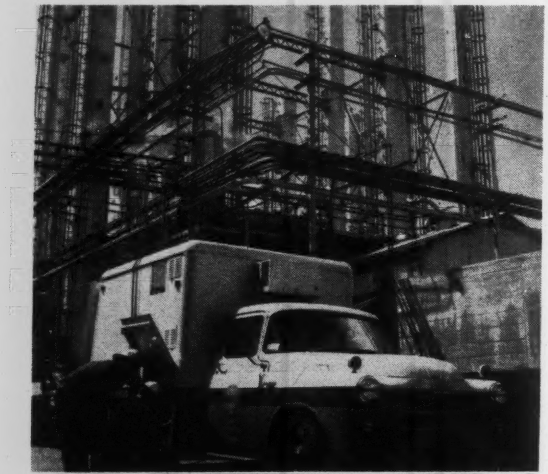
For more information circle **18** on inquiry card.

INSTRUMENTS and AUTOMATION News

Principles & Applications 1460 to 1478
Stock Report 1478
New Plants & Mergers ....1481 to 1482
People in the News ....1487 to 1489

Mobile Lab for Process Study

EMERYVILLE, CALIF.—Shell Development Co. engineers recently put a newly built field test truck into operation. Within the air-conditioned rear compartment are a six-channel recorder, six amplifiers to boost signals from the process, and four triplexers which share three records on one channel. In addition, there is a two-pen pneumatic recorder and a 16-point electronic temperature recorder to monitor pressures and temperatures. Also, there are four field telephones interconnected with a microphone and loudspeaker, all controlled from the truck laboratory.



The test team, after completing all hookups, upsets the operation of the process under study. This is usually done by changing a signal to a control valve. Then sensitive instruments record the reaction of the system at various points in the process as it responds to the input change.

Data thus obtained furnish the company with valuable information for improvements on current or future process control methods.

Radiation Unit Standardization

WASHINGTON, D. C.—The International Commission on Radiological Units and the International Commission on Radiological Protection met April 2-11, 1956, in Geneva, Switzerland. In a move to achieve greater international uniformity of X-ray measurements, the ICRU initiated a project in which basic equipment, to be developed by the National Bureau of Standards, will be loaned to countries which lack primary standards of their own.

The principal outcome of ICRP deliberations was a revised set of recommendations for permissible levels of ionizing radiation to which human beings may be exposed. The latest recommendations of the ICRP state that it is inadvisable for an individual to receive more than 50 roentgens up to his age of 30, 100 roentgens up to age 40, and 200 roentgens up to age 60, in contrast to previous recommendations which permitted exposure of 15 roentgens per week, or between 400 and 600 roentgens per working lifetime.

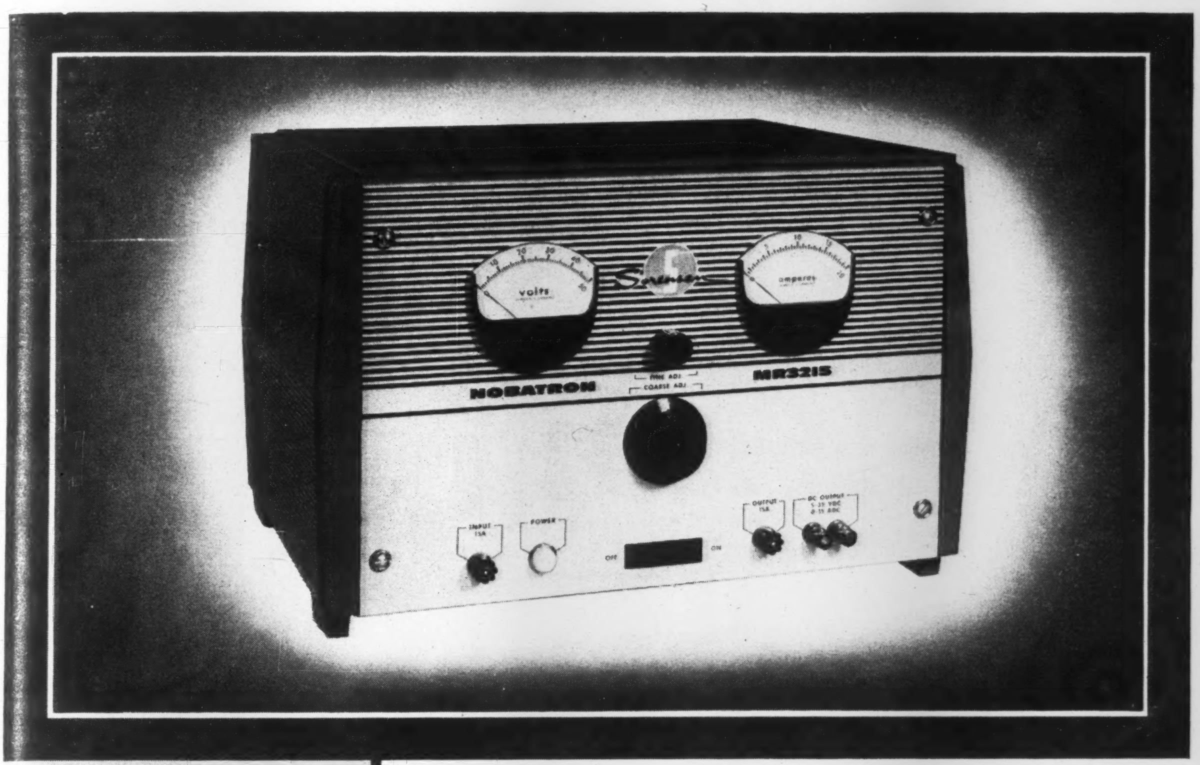
British Instrument Exhibition

LONDON, ENGLAND—The Physical Society (England) held its fortieth Exhibition of Scientific Instruments and Apparatus, May 14 to 17, in the Royal Horticultural Society's Halls in Westminster. It featured 140 exhibitors.

Syncopation by Automation

PASADENA, CALIF.—Datatron, the electronic brain built by ElectroData Div. of Burroughs Corp. has composed history's first ballad by automation.

Dr. Martin L. Klein, mathematician-musician and well known to our readers, has taught the computer the



NEW PRODUCTS . . . BROADER ENGINEERING HORIZONS FROM SORENSEN

MR3215 5-36 VDC AT 0-15 AMPS
new, tubeless, magnetic amplifier

WIDE RANGE REGULATED DC POWER SUPPLY

for versatile, trouble-free performance in countless design & test applications

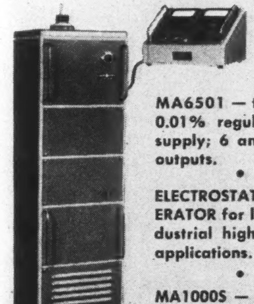
Different outside . . . and *inside!* The latest design in magnetic amplifier regulation. A silicon diode is used as reference element and a transistor amplifier provides the control current for the magnetic amplifier. Wide range, continuously adjustable voltage at high current. Regulation ±0.5% against line or load,* ripple 1% RMS. Versatile, dependable, rugged, economical.

**5-32 VDC; regulation ±1.0% over extended range.*

Write today for detailed specifications, performance data, and quotations.

Sorensen

MA6501



MA6501 — tubeless 0.01% regulated DC supply; 6 and 2 volt outputs.

•

ELECTROSTATIC GENERATOR for lab or industrial high-voltage applications.

•

MA1000S — tubeless, dependable 1000VA regulator, ideal for unattended installations.

MA1000S

SORENSEN & COMPANY, 375 FAIRFIELD AVENUE, STAMFORD, CONN.

For more information circle **19** on inquiry card.

fundamental principles of songwriting. By substituting numbers for notes and equations for rhythm techniques, Datatron now writes popular ballads at the rate of 1000 songs per hour, varying the melodies 10 billion ways. Dr. Klein has long maintained that machines can think and create, once given the basic rules of artistic technique.

With the aid of mathematician Douglas Bolitho, Dr. Martin Klein worked out a formula or computer "program" which is a mathematical expression of melody-writing laws that date back to Mozart and Bach. Introducing a random number from a keyboard the signals start a chain reaction by which Datatron generates thousands of other numbers, each representing one of the eight diatonic notes in the scale with two allowable accidentals. The machine then automatically picks a series of numbers at random, testing each for melodic acceptability.

The first popular song thus composed was presented by singer Jack Owens, July 15, on Dr. Klein's popular-science TV show in Los Angeles.

Potentiometer Design

REDONDO BEACH, CALIF.—A Logistics Research ALWAC III-E electronic digital computer is helping Helipot Corp. solve potentiometer design problems in minutes instead of days. Computation time of nonlinear potentiometers has been cut from 32 man-hours to only 15 minutes.

In designing a nonlinear potentiometer, Helipot engineers must calculate the location of tap connections to the resistance element, the values of padding resistor between taps, and the position of each turn of resistanc wire on the mandrel. This requires the calculation of mathematical function that will cause special coil-windin equipment to lay each turn of resistance wire at th required position.

Magnetism Conference

BOSTON, MASS.—A Conference on Magnetism an Magnetic Materials will be held October 16, 17, and 1 1956 at the Hotel Statler, Boston, Massachusetts.

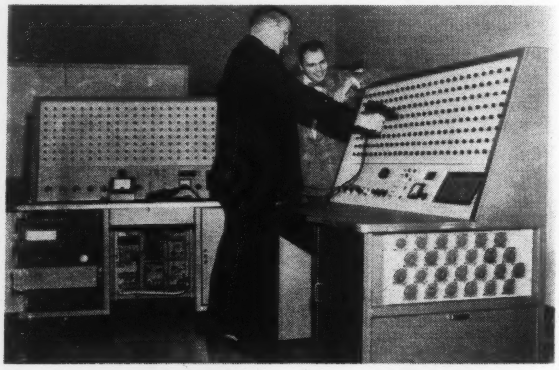
Eight sessions will include approximately 75 technica papers:

I. Magnetic Anisotropy
II. Permanent Magnets and Fine Particles
III. Magnetism and Physical Metallurgy
IV. Losses in Soft Magnetic Materials
V. Ferrites
VI. High Frequency Phenomena
VII. Switching Devices and Magnetic Amplifiers
VIII. Apparatus and Design

For further information contact E. J. Yamartino, Measurements Laboratory, General Electric Co., 40 Federa St., W. Lynn, Mass.

200-Channel Recorder

FULLERTON, CALIF.—Douglas Aircraft Co., ha taken delivery of two Beckman 200-channel recorders t speed structural tests on the Air Force's C-133 turbo-pro cargo plane now being built by Douglas. Strain gages o the airframe send electrical signals that are measured an recorded by the instruments during a test. All 20 channels of each recorder can be sampled in 70 seconds New instrument features include a pinboard programme for simplified operation and a digitizing attachment fo versatility.



With the use of the pinboard, sensitivity control is o a digital basis. For example, a change from 1000 microinches per inch to 2000 microinches per inch is "pinned" to the board. The digitalizer converts the analog signal to digits in the form of punched cards and paper tap which can then be fed into computers for evaluation an study by engineers.

Automatic Concrete Batching

NEW YORK, N.Y.—Punch-card electronic batchin has invaded the building trade. A system developed b

There's 1 source for 2 way 3 way or 4 way MIDGET SOLENOID VALVES

SEE ASCO Booth 1615-1616 at the Instruments Show, New York Coliseum, N.Y.C.—Sept. 17th-21st.

Progressive designers, the men who lead the trend toward miniaturization, depend on ASCO as the one source for a full line of midget solenoid valves. The unexcelled quality and dependability that ASCO pioneered in the solenoid valve field is found, too, in today's midget solenoid valves. Only the size has been reduced.

For flow applications using air, gas, water, light oil, refrigerants and many other liquids, ASCO Midget Valves assure complete safety and truly exceptional performance.

ASCO Midget Solenoid Valves are available with standard, watertight or explosion-proof enclosures. Pipe sizes 1/8" and 1/4"; pressure range 0-1000 psi.

There's *one* source that solves virtually any solenoid valve problem — ASCO. Write today for complete data on ASCO Midget Solenoid Valves — or outline any of your requirements. We'll be pleased to assist you.

SHOWN ¾ ACTUAL SIZE

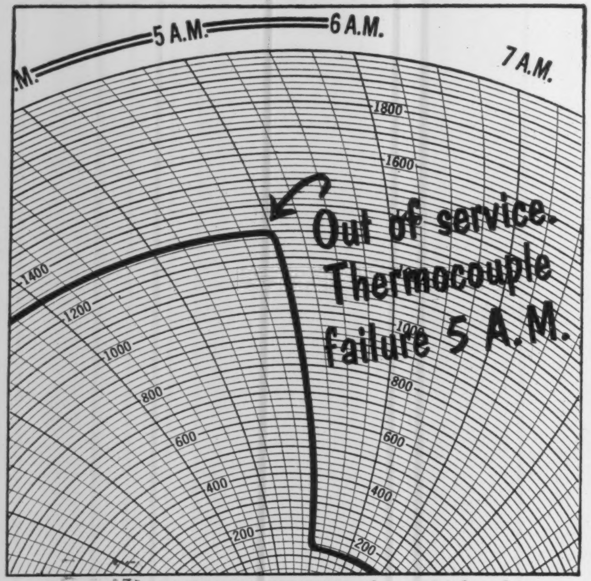
ASCO®

Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

Automatic Switch Co.

[illegible] Lakeside Avenue • Orange, New Jersey

For more information circle **20** on inquiry card.



YOU CAN CUT INSTRUMENT DOWN-TIME for service from hours to minutes in most cases with an adequate supply of Bristol thermocouples and pyrometer accessories.

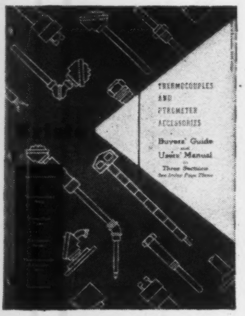
How much can interrupted pyrometer service cost you?

Now's the time to worry—before it happens—about what interrupted pyrometer service can do to your production schedules, cost figures, and quality controls.

And now's the time to lay in a supply of Bristol's pyrometer supplies and accessories to cut down-time to a minimum. Bristol's complete line of thermocouples, protection tubes, radiation-unit accessories, refractory insulators, mounting fixtures, thermocouple wire, and extension wire, switches, ink, and charts, are available in a wide selection of interchangeable sizes and types to fit all standard installations.

They're backed by Bristol's 51 years experience in industrial pyrometry. We've built thousands of pyrometers for every application—in iron, steel, non-ferrous metal smelting and refining; in petroleum, chemical, ceramics, glass, paper, and food-processing industries and in power, heat and incineration utilities.

You'll find these pyrometer supplies completely described in our 56-page Bulletin P1238, together with technical data on selection, installation, maintenance, and calibration. Write for your copy today. The Bristol Company, 154 Bristol Rd., Waterbury 20, Conn.


THERMOCOUPLES AND PYROMETER ACCESSORIES
Buyers' Guide and Users' Manual

FREE BULLETIN P1238. Tells how to select, install, calibrate and care for thermocouples and pyrometer accessories.

6.18

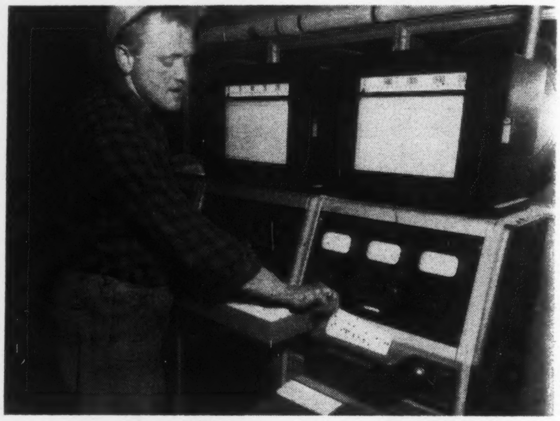
BRISTOL *Points the Way in Human-Engineered Instrumentation*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **21** on inquiry card.

NEWS—CONTINUED

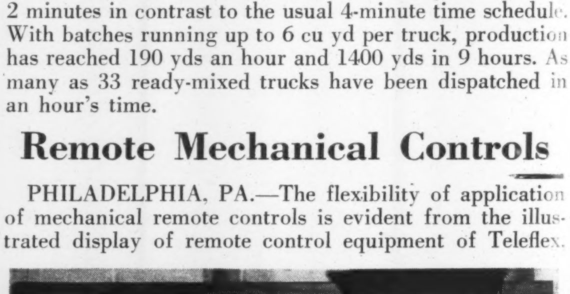
Fairbanks, Morse & Co. in collaboration with Butler Bin Co., called the Butler Bin Type XKI, employs cards perforated to indicate the weights of materials for each specified mix and an electronic batching instrument which "reads" the punches in the card and automatically weighs out the correct proportions of ingredients on Fairbanks-Morse hopper scales for discharge to the mixer. Both wet and dry ingredients can be handled and compensation for moisture in the dry materials can be made automatically through a dial setting. According to the manufacturer, with a set-up tried by Cleveland Builders Supply Co., it is possible to obtain any one of 15,000 different formulations using up to six different components.



A 6-cu-yd batch of concrete can be dispatched every 2 minutes in contrast to the usual 4-minute time schedule. With batches running up to 6 cu yd per truck, production has reached 190 yds an hour and 1400 yds in 9 hours. As many as 33 ready-mixed trucks have been dispatched in an hour's time.

Remote Mechanical Controls

PHILADELPHIA, PA.—The flexibility of application of mechanical remote controls is evident from the illustrated display of remote control equipment of Teleflex Inc., which includes control boxes, quick disconnects, hobbed wheels, telescopic units, etc. Superior Tube Company, which supplied the tubing used in manufacturing these controls, reports that jet-age applications have produced many high-temperature and low-temperature problems, requiring extensive materials research by Teleflex and Superior Tube.



ONE GOOD DESIGN DESERVES ANOTHER

Send for VALCOR Catalog
VALCOR Solenoid Valves are engineered for use in food vending machines, machine tools, chemical, food and drug processing industries, oil burners, air-conditioning, laundry machinery, air and hydraulic cylinders and other general industrial and fluid power applications.

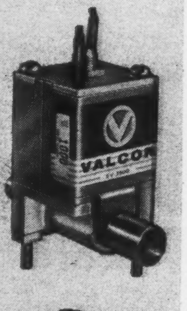
VALCOR
SOLENOID VALVES

Series SV-300
2 Way Brass Body
Normally Closed.
For use with water, oil, air and gases.
PIPE SIZES 1/8" or 1/4" N.P.T.
Elec.: 115V-60 cy., 10 watts
Max. Pressure: 125 lbs.

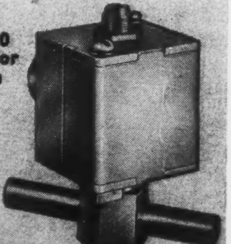
Series SV-900
3 Way Brass Body
For use with water, oil, air and gases.
PIPE SIZES 1/4" N.P.T.
Elec.: 115V-60 cy., 10 watts
Max. Pressure: 125 lbs.
Normally Closed or Normally Open

Series SV-1000
4 Way Brass Body
For use with water, oil, air and gases.
PIPE SIZES 1/4" N.P.T.
Elec.: 115V-60 cy., 10 watts
Max. Pressure: 125 lbs.

Series SV-3600
2 Way Metal or Plastic Body
For use with hot and cold liquids—will handle extra heavy viscosities and large flows. Male fittings for 3/8" I.D. Tubing
Elec.: 115V-60 cy., 10 watts
Max. Pressure: 100 lbs.
Normally Closed



Series SV-3500
Freon Valve for refrigeration



2 Way—Designed to take full back pressure.
Max. Pressure: 350 lbs.
This valve is manufactured in accordance with standard refrigeration specifications. Quotations on request.

Incorporate VALCOR Solenoid Valves with the exclusive Floating Seal in the Systems you Design

Here's why: Every VALCOR Solenoid Valve is engineered with this unique and exclusive combination of features.

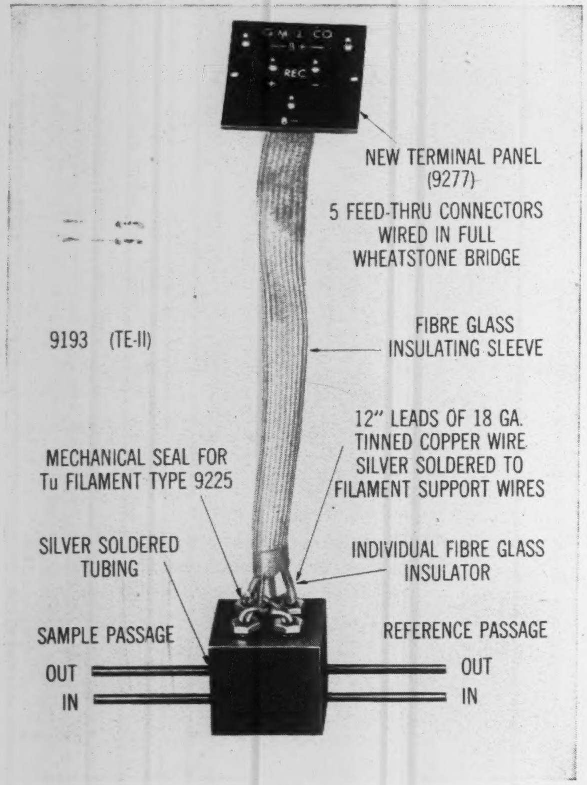
a) VALCOR'S Patented Floating Seal for 100% positive seal forward and backward.
b) Extremely low pressure drop.
c) Self-cleaning, self-lapping seal action that improves with use.
d) Greater capacities with smaller orifices.
e) Simplicity of design that guarantees high durability and long life even under extreme operating conditions, including heavy contaminent conditions.

VALCOR Solenoid Valves afford top performance in every possible application. Design engineers in industry after industry are discovering the freedom of design that VALCOR Valves permit. Simplify your design problems. Write us for more information and tell us also about your problems.

VALCOR ENGINEERING CORPORATION
Carnegie Avenue, Kenilworth, New Jersey

For more information circle **22** on inquiry card.

GOW-MAC CELLS for GAS CHROMATOGRAPHY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NEW TERMINAL PANEL (9277)
5 FEED-THRU CONNECTORS WIRED IN FULL WHEATSTONE BRIDGE
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FIBRE GLASS INSULATING SLEEVE
12" LEADS OF 18 GA. TINNED COPPER WIRE SILVER SOLDERED TO FILAMENT SUPPORT WIRES
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- T/C CELLS FOR 225°C OPERATION
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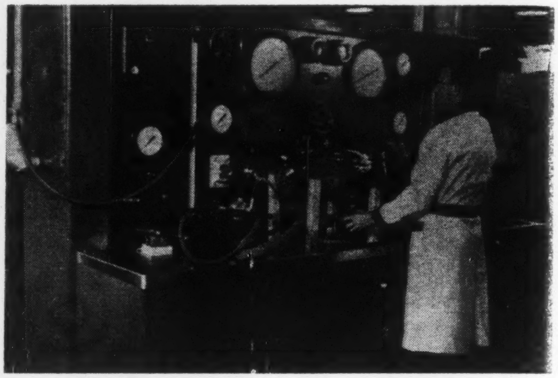
11th ANNUAL INSTRUMENT-AUTOMATION CONFERENCE AND EXHIBIT—NEW YORK COLISEUM, NEW YORK
SEPTEMBER 17-21, 1956

GOW-MAC INSTRUMENT CO.
100 KINGS ROAD, MADISON, N. J.

For more information circle 23 on inquiry card.

Valve Test Equipment

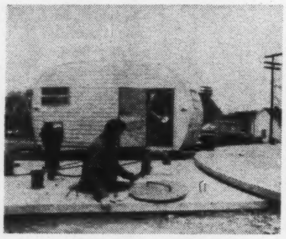
CORRY, PA.—A specially designed hydraulics test machine has enabled Aero Supply Mfg. Co., Inc., Corry, Pa. to more than double the speed with which it can test precision control valves for leaks, holes, pressure drop, microscopic flaws and defects. As many as four tests can be run at one time on a single hookup.

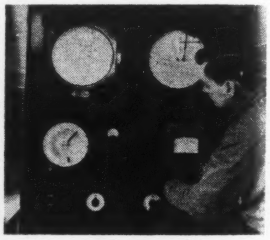


The unit is equipped with a 22-gpm 500-psig fuel pump. It is designed for pumps that can deliver 50 gpm at 1500 psig. Also built into the machine is a power supply, electric stop clock, and a high pressure fuel booster capable of delivering 3000 psig static pressure.

Checking Plant Waste Effluents

PHILADELPHIA, PA.—The Water Department of Charlotte, N. C. has equipped two trailers to make 24-hour tests of plant effluents by continuous measurement of pH, flow rate, and total volume of flow. The heart of the equipment is a Speedomax H pH-recorder manufactured by Leeds and Northrup Co. Two Hagan flow meters with integrators chart the rate of flow.





Charlotte's engineers, therefore, can verify that conditions of plant effluent have remained within the permissable limits of 6 to 9 pH throughout the 24-hour test period.

Electronics' Future Role

SAN FRANCISCO, CALIF.—At the recent Summer and Pacific General Meeting of the American Institute of Radio Engineers, Dr. Allen B. Du Mont discussed present and future trends in electronics. He said that the cathode-ray oscillograph or "scope" is the key to the electronic age, and predicted that the writing speed of the beam of an oscillograph can be increased in the near future to a speed faster than the speed of light, making possible the measurement of extremely high-speed

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More than 170 exhibitors—all of them top companies—represent a vast range of equipment and services for instrumentation and automation: automatic control systems; highly automatic machine tools; digital and analog computers; automatic inspection devices; communication systems, including closed circuit television; feeding devices; work positioning mechanisms; and electronic, electrical, and mechanical components which make up automatic production systems.

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Vanderbilt

WRITE DIRECTLY TO THE HOTEL—Mention the Third International Automation Expositio

phenomena such as nuclear reaction and radioactive scintillation.

Dr. Du Mont told of infrared pickup systems that enable a hospital ward in complete darkness to be under constant observation by television means. He discussed a new oscillograph for use in hospital operating rooms which will constantly monitor the action of the patient's heart. Dr. Du Mont also discussed the future probability of a comprehensive electronic device that would enable medical men to make an almost complete physical check of a patient in a matter of seconds.

Heatproof Garment

NEW YORK, N.Y.—A suit that enables a man to work in temperatures "one-eighth as hot as the sun's surface" was demonstrated recently. The demonstrator six times entered an industrial furnace heated to 1200°F, the highest temperature ever entered publicly for more than a few seconds. He stayed two or three minutes each time.

The demonstration was sponsored by Minnesota Mining and Manufacturing Co., to show the heat-protective qualities of fabrics coated with a thin layer of aluminum which reflects radiant heat. The demonstrator sat in a wicker armchair while it burned, and topped off the demonstration by carrying in a half-inch-thick steak that cooked to medium-rare in about 1½ minutes—while he didn't.

The suit in the demonstration—produced by Fyrepel Products, Inc., Newark, Ohio—has the aluminum coating on a fibre glass material which is backed up with fibre glass quilting.

News Bits

CONSOLIDATED ELECTRODYNAMICS CORP. has received an order from ARDC to provide magnetic-tape instrumentation along the 5,000 mile intercontinental ballistic missile test range. The magnetic-tape equipment, placed at over 100 strategic points on the ground and aboard ships along the 5,000 mile range, will record telemetered data from missiles and play it back for analysis and interpretation.

BERKELEY DIV., Beckman Instruments Inc. demonstrated quality control facilities and product applications at their open house June 26.

LEEDS & NORTHRUP has become a member of Atomic Power Development Associates, Inc., and L&N President I. Melville Stein has been elected a director of

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TIME-RECORDER + TOTALIZER

gives complete production data continuously . . . automatically

Now get complete, accurate, documented production data on any machine, process, operation. Eliminates costly, inaccurate spot-checks, time studies.

TR+T records on continuous 4-month tape. Uses no ink. No maintenance. Thousands in use in large and small plants.

Chronologically records actual on-and-off time by duration.

Gives absolute time-study data per operation.

Establishes true cost accounting.

Permits supervision of parts replacement, repairs, maintenance.

Gives total operating time of machine, feed or belt-line.

Allows ability to anticipate equipment servicing.

Write for brochure "M" and list of users.

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"PRECISION-GAUGED" HAIRSPRINGS

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High volume production with absolute uniformity

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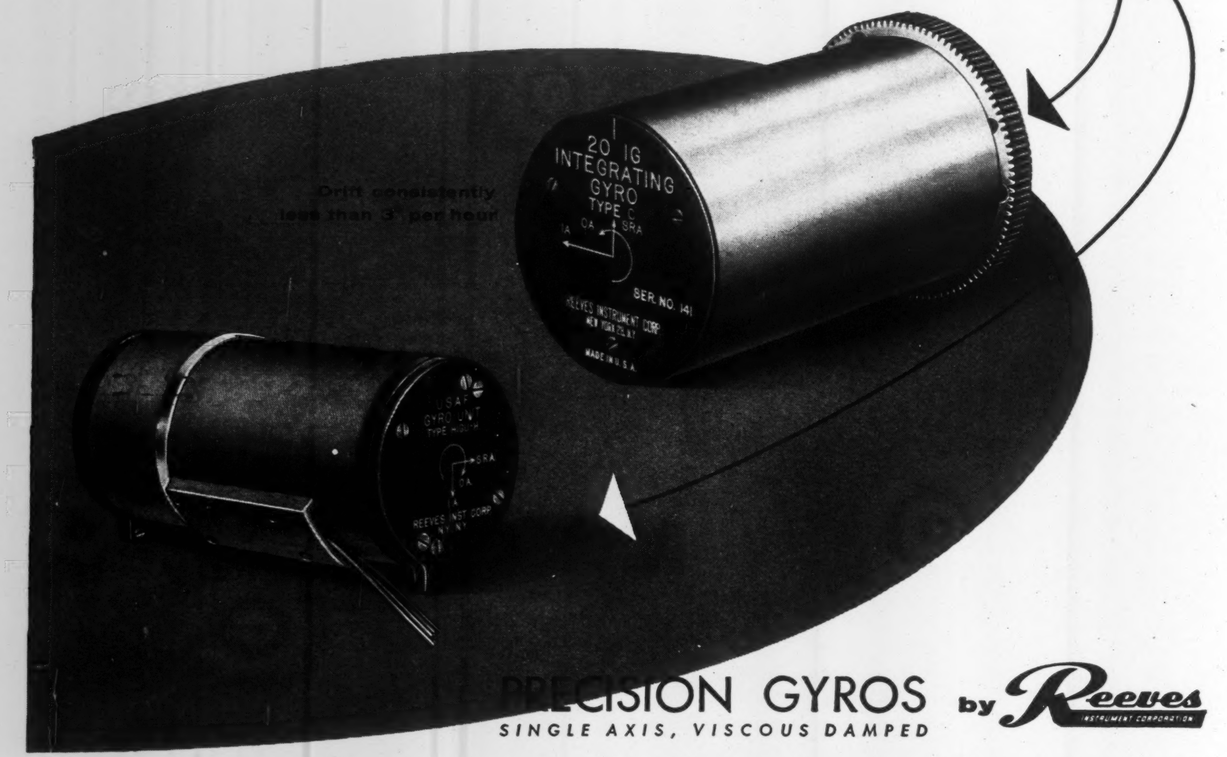
in volume production . . .

backed by 5 years' know-how and over 10,000 units in service


Drift consistently less than 3° per hour
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INSTRUMENT CORPORATION

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No manufacturer can show a matching record of precision engineering achievement in this most exacting department . . . or better our record of PROVED service in the field. Reeves was one of the first to achieve quantity production to high precision standards of the HIG-5 Gyro . . . the "work-horse" of the gyro field.

Now Reeves has stepped up volume on the new HIG-4 to meet both military and commercial needs . . . with these exceptional features:

EXTREMELY LOW DRIFT: Trimmed drift rate less than 3° per nour.

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EXTREMELY COMPACT: Only 2" dia. x 3" long.

Reeves is now ready to meet your requirements with a full range of single-degree-of-freedom, viscous damped rate and integrating gyros and accelerometers, volume produced to exceptional standards in one of the finest gyro facilities in the world. Outline your needs for our recommendations.

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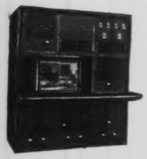
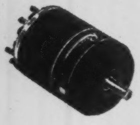
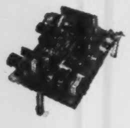


REAC Analog Computers

Precision Floated Gyros



Precision Resolvers and Phase Shifters



Servo Mechanical Parts

Reeves
INSTRUMENT CORPORATION

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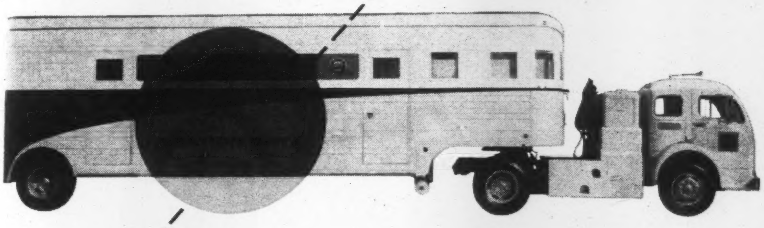
at ISA



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Operation Data

Application engineers will conduct small groups by appointment . . . giving you an unusual opportunity to view an operating data processing system, featuring high speed commutation and electronic analog-to-digital conversion A variety of input and output devices complete the system.
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Process Refractometers
Oxygen Analyzers
Ultraviolet Analyzers
Titrilog Sulfur Recorders
Leak Detectors

HIGH-VACUUM EQUIPMENT
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Metalizers
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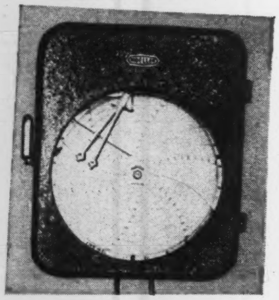
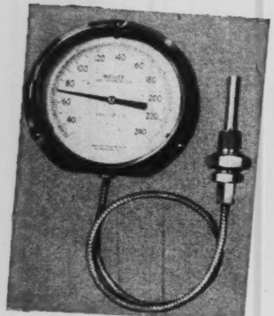
dependability You get PLUS with Moeller dials and recorders

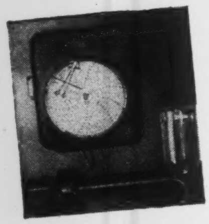
Adjustable Form Dial Indicating Thermometers with separable socket. Can be quickly adjusted to any angle.



Single and Multiple Pen, Remote Recording Thermometers. Available for one and two temperature recordings in round cases and up to four temperature recordings in rectangular cases.



Remote Reading Dial Thermometers. Mercury actuated, with separable socket. Panel or flush mounting.



Moeller Recording Psychrometer Type No. 6630 (wet and dry bulb temperature type) for accurate humidity determinations and records. Designed for rooms or apparatus where air circulation is poor.

...because our business is the design and manufacture of temperature measuring instruments—and has been since 1867.

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NEWS—CONTINUED

the group. APDA is a non-profit corporation formed by 44 private companies pooling money and technical know-how to do the research and design work on a nuclear power plant.

MONROE CALCULATING MACHINE's Electronics Div. has delivered the first MAID (Monrobot Automatic Internal Diagnosis), a device which constantly monitors the operation and 3000 parts of the ARDC's Monrobot VI electronic computers to ensure correct answers.

A BAUSCH & LOMB-made diffraction grating will be installed in a specially-designed spectrograph to be used in Adelie Land in the Antarctic, where French physicists expect to detect the hydrogen showers occurring in the region. They hope thus to be able to measure the speed of incoming proton beams as their contribution in the International Geophysical Year program.

B & L Diffraction Grating

Beckman Spectrophotometer

POMONA TILE Mfg. Co., Pomona, Calif. claims to have "the most scientifically quality-controlled plants in U.S." A spectrophotometer (Beckman) makes a rapid chemical analysis of the material going into tiles, and differential thermal analysis equipment provides additional analytical information.

THOMAS A. EDISON, Inc. announced a new electromechanical pressure indicating system which will go into the supersonic F-104 fighter plane. Unaffected by vibration, a variable-reluctance-type transmitter mounts directly on the engine and is connected through ordinary wire to the wide-angle voltage-ratio-type indicator on the control panel.

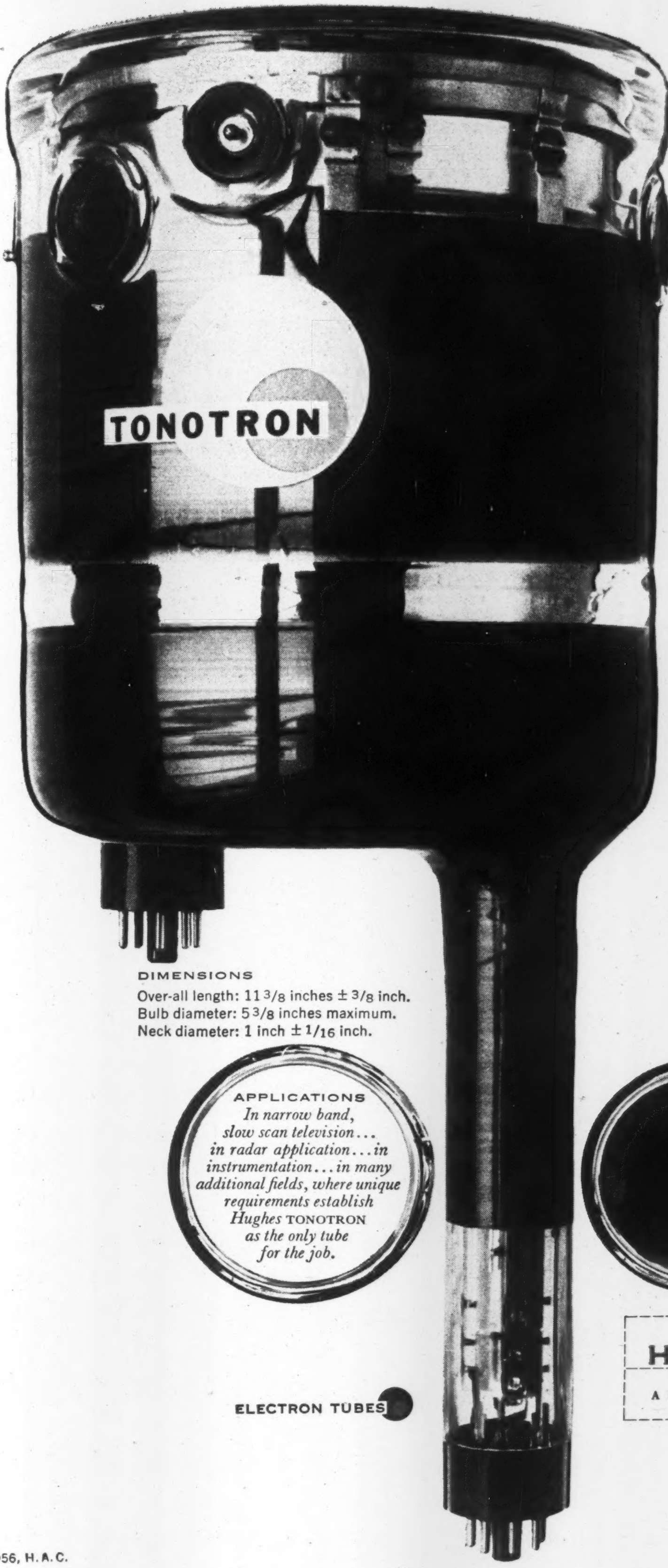
TRANSISTORS now are being used by GE in prototype radiation detection instruments at the Hanford atomic plant, while Bell Telephone Labs have built a large fully transistorized coincident-current magnetic-core memory.

BERKELEY DIVISION of Beckman Instruments is building a huge analog computer for General Motor's Allison Division, to simulate jet engines electronically.

STROMBERG-CARLSON will provide the electronic equipment for controlling the flow of air in the world's largest supersonic wind tunnel, now under construction at USAF's Arnold Engineering Development Center.

GENERAL ELECTRIC has received a contract to develop super-sensitive instruments needed to measure extremely critical temperature, pressure and liquid level in the coolant loop of the U. S. Navy's atomic submarines' propulsion reactors.

AVIATION WRITERS recently formed in San Francisco an International Society (ISAW) to encourage high standards of aviation writing for peaceful ends.



Hughes Products proudly announces

TONOTRON

Full circle persistence • New brilliance
Defies sunlight

Hughes Products introduces the TONOTRON, *another in its series of new, direct-display cathode ray tubes designed for commercial, industrial, and military applications.*

FEATURES

With TONOTRON, high-fidelity picture reproduction is possible for the first time. This new tube displays black, white, and *all* intermediate shades—with persistence which can be adjusted to maintain nearly maximum brilliance throughout the major portion of a 360-degree sweep. Both persistence and rate of decay can be controlled to suit a variety of specific applications. And TONOTRON's extreme brilliance makes observation possible in the brightest sunlight without a hood.

DIMENSIONS

Over-all length: 11 3/8 inches ± 3/8 inch.
Bulb diameter: 5 3/8 inches maximum.
Neck diameter: 1 inch ± 1/16 inch.

APPLICATIONS

In narrow band, slow scan television... in radar application... in instrumentation... in many additional fields, where unique requirements establish Hughes TONOTRON *as the only tube for the job.*

ELECTRON TUBES

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

For additional information, please write:
HUGHES PRODUCTS
ELECTRON TUBES
International Airport Station, Los Angeles 45, California

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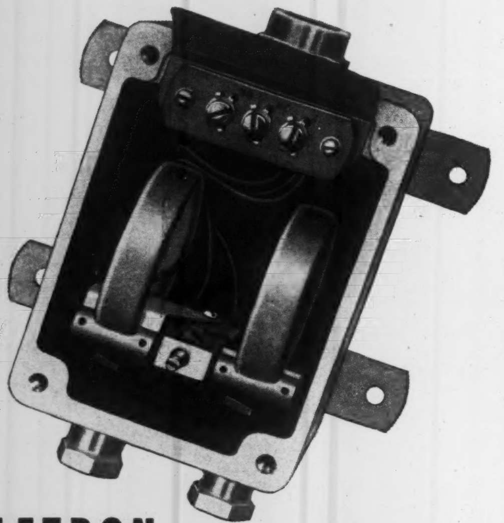
For more information circle **29** on inquiry card.



MELETRON
DIFFERENTIAL SWITCH
senses pressure differences from 4 to 9000 p.s.i.
with Proof Pressures ranging from 500 to 12,000 P. S. I.

A good illustration of this switch function is its application on multiple stage compressors. If a failure occurs in one of the stages the switch will signal the pressure difference change or shut down the system to prevent damage.

EXTREMELY ACCURATE
Simplicity of direct acting design plus rugged precision construction make for long, unchanging repeat accuracy.

Note, that we don't use LINKAGES AND BEARINGS which, as they wear, cause settings to drift.

IN ANY POSITION
on moving equipment, even under vibration, switch performs with equal efficiency.

Because we don't use LIQUID SWITCH ELEMENTS which require that the pressure switch be mounted absolutely vertical, which make it very critical to vibration.

To get complete operating characteristics and specifications ask for bulletin 532

BARKSDALE VALVES
PRESSURE SWITCH DIVISION
5125 Alcoa Avenue, Los Angeles 58, California

For more information circle 30 on inquiry card.

NEWS—CONTINUED

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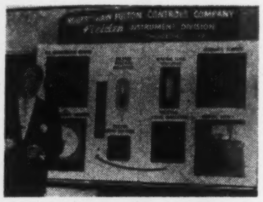
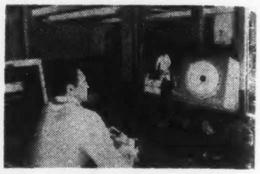


Fielden Traveling Exhibit



Baldwin Torque Pickups

BALDWIN SR-4 torque pick-ups from four test stands are hooked up to indicator for supervising life tests on Ford tractor axles and gears.

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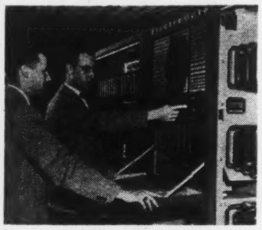
DATATRON will be the featured exhibit at the new Mid-America Exhibit Center opened on July 25 at 324 South Michigan Ave., Chicago, Ill.



Burroughs' Datatron

Allegheny Ludlum's Vacuum Melting Dept.

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Continued on page 1478

NEW 10 STAGE 3/4" multiplier phototube

Actual Size

DU MONT Type K1382

In the new Type K1382, Du Mont offers the first ¾" multiplier phototube with the ruggedness of field equipment combined with the performance of a laboratory tube.

The average gain of the Type K1382 of 300,000 at 105 volts/stage exceeds that of many laboratory tubes, with no sacrifice in long-term stability for which Du Mont multiplier phototubes are noted.

In addition to its small size and superb operating characteristics, the Type K1382 is unusually rugged. This tube has been designed for the roughest service under the worst climatic conditions. The tube base is potted and all leads jacketed to permit operation under severest humidity without leakage between leads. **Laboratory performance** can be obtained from this tube even when it is being dropped as a probe into a drill hole far underground.

As in other Du Mont multiplier phototubes, the linear box-type dynode structure is used. This means optimum electron collection greatly improving signal-to-noise ratio. Also, long leakage paths minimize noise and dark current. Dark current is only 0.1 ua at 105 v/stage and 25°C.

The small size and excellent performance of the new Type 1382 mean an extra bonus to users in the geological surveying field where, for example, its extra gain permits much longer signal transmission from underground locations before signal level becomes too low to be useful. It should be exceptionally useful in medical physiological probing. Batteries of these tubes may be used for speedier diagnostic procedure. In addition, the small size will help greatly in the miniature and portable designs that can function at least as well as laboratory equipment.

CONDENSED SPECIFICATIONS

Average gain:	300,000 at 105 v/stage
Maximum dark current:	0.1 ua max. at 105 v/stage and 25°C
Photocathode sensitivity:	40 ua/ lumen
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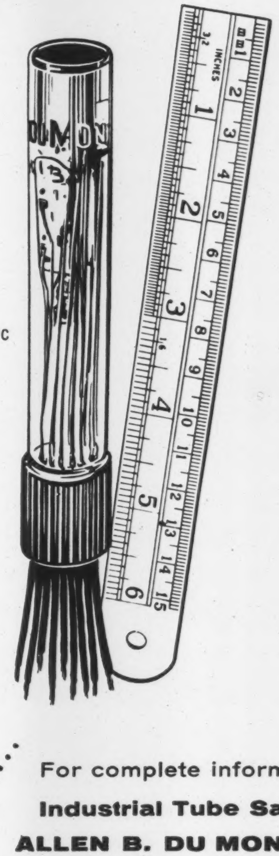
Maximum outside diameter:	no greater than ¾"
Physical Characteristics:	potted base, jacketed leads



DU MONT®

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ALLEN B. DU MONT LABORATORIES, INC.
2 Main Ave., Clifton, New Jersey

DON'T MISS THE DU MONT TUBE EXHIBIT AT WESCON BOOTHS 929-930

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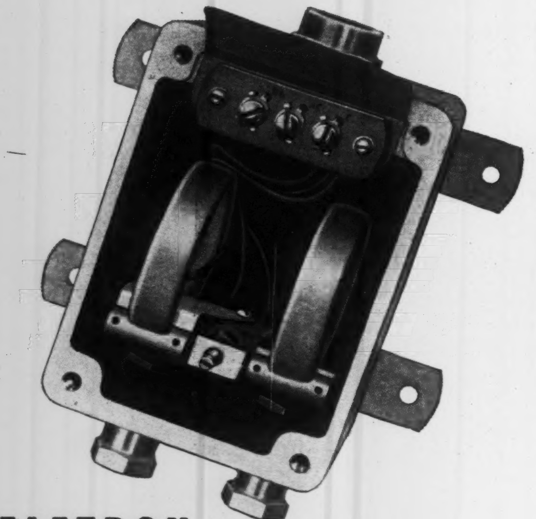

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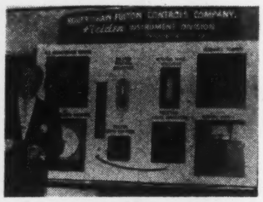

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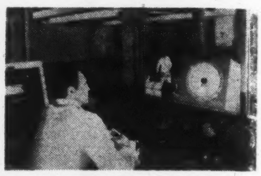

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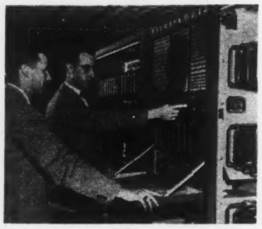

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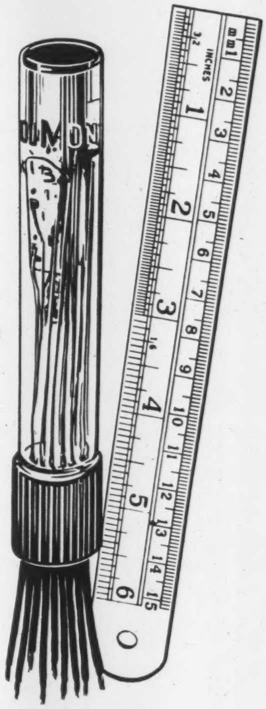

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For more information circle **31** on inquiry card.

for HAZARDOUS LOCATIONS

SKINNER ELECTRIC VALVES ®

SKINNER EXPLOSION-PROOF Solenoid Valve
Only $3\frac{27}{32}''$ high

Skinner X5 Series Explosion-Proof stainless steel Valves are ideal for use in hazardous applications. They are Underwriter Approved for Class I (Gasoline vapors, etc.), and Class II, Groups F (Grain dust) and G (Coal and coke dust), and offer you incomparable simplicity and flexibility of design.

These low-cost valves are expertly engineered to give trouble-free performance through millions of cycles. They're direct-acting, leakproof and spring loaded for operation in any position. Available in a wide range of types, voltages, pressures, flow control adjustments, port sizes and port locations.

SPECIFICATIONS: Type: Two- and Three-Way Normally Open, Normally Closed, and Directional Control; Pressure Range: 0-1000 p.s.i. Orifice Diameters: $\frac{3}{64}''$ to $\frac{1}{4}''$. Pipe size: $\frac{1}{8}''$ or $\frac{1}{4}''$ NPT; Voltage All AC and DC; Duty Cycles: Continuous or Intermittent. *Write today for Bulletin 526A*

Visit Skinner Booth No. 1813,
Instrument Conference and Exhibit,
New York City, Sept. 17-21

SKINNER

SKINNER ELECTRIC VALVE DIVISION · SKINNER CHUCK COMPANY

THE CREST OF QUALITY

SKINNER · ELECTRIC VALVES · ®

SOLENOID **VALVES**

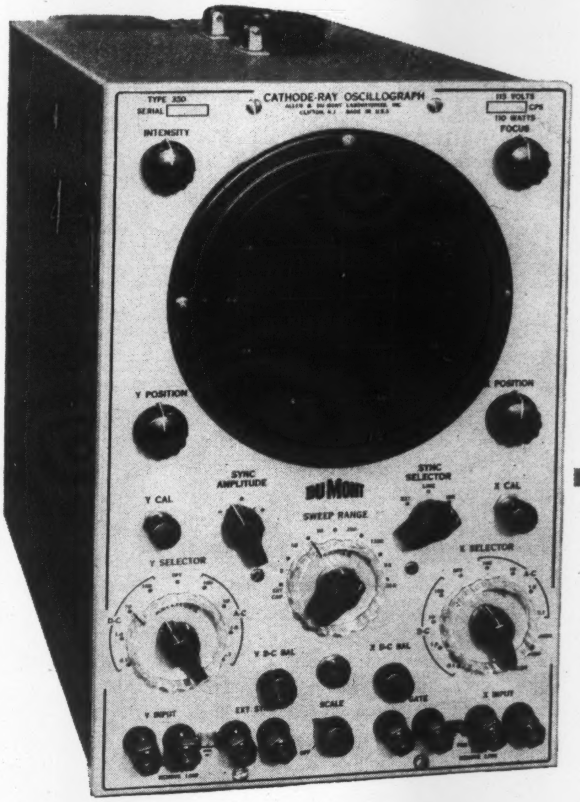
116 Edgewood Avenue
New Britain, Conn.

WORLD-WIDE REPRESENTATION

For more information circle **32** on inquiry card.

THE *New* CHAMPION

350


TYPE 350
SERIAL
CATHODE-RAY OSCILLOGRAPH
115 VOLTS
CPS
110 WATTS
INTENSITY
FOCUS
Y POSITION
POSITION
SYNC AMPLITUDE
DU MONT
SYNC SELECTOR
SWEEP RANGE
Y CAL
X CAL
Y SELECTOR
X SELECTOR
Y D-C BAL
X D-C BAL
SCALE
Y INPUT
X INPUT

Not just another low-frequency cathode-ray oscillograph but a decidedly grown up instrument combining the best features of the laboratory standards by Du Mont which have gone before it. All these features and more:

- **Exceptional stability—all voltages regulated**
- **No drift—less than 10 mv in 8 hrs. including 10% line voltage changes**
- **Identical X- and Y-amplifiers**
- **Amplitude calibration on both axes**
- **Accurate X-Y plotting at frequencies from d.c. to 150 kc.**
- **Ideal for precise phase shift measurements—less than 1° relative phase shift below 150 kc.**
- **Superior sweep linearity with hard-tube circuit**
- **Automatic beam brightening on sweeps**
- **Automatic beam brightening for transient plots**
- **High brightness—3KV acceleration**
- **Provision for very slow sweep rates**

CONDENSED SPECIFICATIONS:

VERTICAL DEFLECTION: *sinusoidal response,* flat to d.c., down not more than 30% at 150 kc; *deflection factor,* 20 p-p mv/inch.

HORIZONTAL DEFLECTION: identical to vertical axis except *deflection factor,* 25 p-p mv/inch (due to higher deflection factor of horizontal deflection plates).

SWEEPS: *mode,* driven or recurrent; *frequency,* 2 cps to 30 kc; *beam gate,* automatic during forward sweep.

AMPLITUDE MEASUREMENT: (both X and Y axes) *range,* 0.1, 1, 10 and 100 volts full scale; accuracy, ±5%.

PHASE SHIFT: *amplitude controls at max.,* less than 1° below 150 kc.

PRICE ONLY **$395**

IMMEDIATE DELIVERY!

Write for complete specifications

DU MONT

ALLEN B. DU MONT LABORATORIES, INC. [illegible]

DON'T MISS THE DU MONT INSTRUMENT EXHIBIT AT WESCON BOOTHS 939-940

For more information circle **33** on inquiry card.

Chalmers" by L. J. Linde and Hal Cory, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

AFCRC (Air Force Cambridge Research Center) has undertaken, for the third time in three years, to chart the jet stream—a "river of air" that flows continuously from west to east at altitudes between 25,000 and 40,000 feet. The plane to be used is a specially instrumented B-47 medium bomber. The possibility of flying the jet stream, which sometimes attains speeds of 250 mph, by use of an automatic navigator (the APN66, manufactured by General Precision Labs) will be investigated.

AMF Atomics, Inc., subsidiary of American Machine & Foundry Co., is supplying the Federal Republic of Germany with a one-megawatt "swimming pool" type reactor. It will be used in Munich's Technische Hochschule (Technical University) for training engineering students in nuclear science.

Stock Report

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York.

New York Stock Exchange:

	Price Range for 1956 Thru July 3		As of July 3
Security	High	Low	Last
Aeroquip	15 3/8	11 7/8	14 7/8
American Chain & Cable	48	38 1/2	45 1/2
American Mach. & F.	32 1/8	24 1/8	28 3/4
American Mach. & M.	40 3/4	35 1/8	37 1/4
American Optical	40 3/4	34 1/2	34 3/4
Beckman Instruments	31 1/2	25 1/8	30 1/2
Bell & Howell	45 1/2	28 1/4	40 - 40 3/4 (1)
Bendix Aviation	63	48 1/2	51 3/4
Bulova Watch	23	20 1/4	21 1/4
Burroughs	44 3/4	28 1/2	43 1/4
Clevite	24 1/4	18	18 1/2
Dobeckmun	39 1/4	31 1/2	32 3/4
Gamewell	31 1/2	25 5/8	29 1/4
General Inst.	10 1/8	7 5/8	7 5/8
General Prec.	53 1/2	37 1/2	38
General Time	33 1/8	29 1/2	30 1/2 - 31 1/4 (1)
Hamilton Watch	25	19	23 - 23 1/2 (1)
International Business Mach.	510	400	487 1/2
Minneapolis-Hon.	85 1/2	58	85
National Cash Reg.	56	34 1/8	53 3/8
Radio Corp.	50 3/8	41 1/8	42 1/2
Raytheon	19 1/2	14 5/8	15
Robertshaw-F.	28 3/8	21 1/2	23 7/8
Sangamo Electric	37 1/2	29 1/2	35 1/2
Sperry Rand	29 1/8	23 5/8	24 1/2
Square D	74 1/2	51 1/2	73
Starrett, L. S.	56 1/2	43 3/4	50 3/4 - 52 (1)
Sylvania Electric	55 7/8	42	51 1/2
Telautograph	15 1/4	11	14 1/4
Texas Inst.	14	11 5/8	13 3/4
Underwood	44	29 5/8	29 7/8

(1) Bid - Asked price, no sale

American Stock Exchange:

	Price Range for 1956 Thru July 3		As of July 3
Security	High	Low	Last
Air Assoc.	13 1/2	9	9 7/8
American Meter	41	33	33 1/2
Benrus Watch	10 3/8	8 7/8	9
Breeze Corp.	9 1/8	6 1/4	6 5/8 - 7 (1)
Consolidated Electrodynamics	27 7/8	21	27 5/8
DuMont Labs.	10	5 3/4	5 3/4
ElectroData	22 3/8	13 1/2	21 1/2
Fairchild Camera & Instr.	25 1/4	19 1/2	23 1/2
Int'l Resistance	8 1/4	6	6 1/8
Lear Inc.	10 1/4	7 1/2	7 7/8
Nat'l Res. Corp.	29 3/4	17 7/8	22 1/4
Neptune Meter	34 7/8	28 3/8	31
New Haven Clock	2 1/2	1 1/2	1 1/2 - 1 3/4 (1)
Norden-Ketay	14 7/8	9 5/8	9 3/4
Pneumatic Scale	28 1/4	24 1/2	24 3/4 - 25 3/4 (1)
Servomechanisms	9 1/2	8 1/4	8 3/4
Wallace & Tiernan	22 1/2	19 1/2	20
Waltham Watch	3	1 1/4	1 1/2

(1) Bid - Asked price, no sale.

Across the Street

from the NEW YORK COLISEUM, in our show room, you will find a complete display and demonstration

- Gas analysors for oxygen, helium, and carbon dioxide on the thermal conductivity principle.
- Capnograph CO_2 analysor on infra-red absorption principle.
- Servo-graphic recorder.
- Biochemical and laboratory equipment and accessories.

Exhibitors at the 11th Annual Instrument Exhibit at the New York Coliseum—Sept. 17-21 are cordially invited to consult us for servicing facilities. Visit us or call CIrcle 5-5590.

INSTRUMENTATION ASSOCIATES
17 West 60th Street, New York 23, N. Y.

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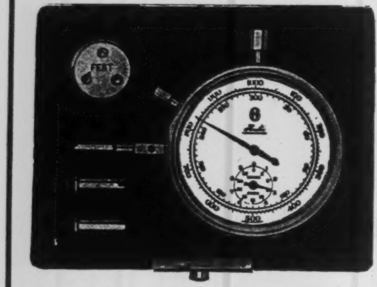
HASLER SPEED INDICATOR
Chronometric Tachometer with separate reset button for cumulative readings



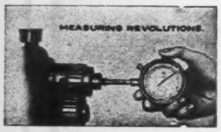
Accurate
Automatic
Durable
Flexible
Portable
Non-magnetic

Size
2¾" x ⅞" x 4"
Spindle incl.

Weight
7¾ oz.
ready for test

Type A 0-20,000 r.p.m.
or 0- 6,000 f.p.m.
Type B 0- 2,000 r.p.m.
or 0- 600 f.p.m.
Shipment within 5 days from stock

To order:
Type A 0-30,000 r.p.m.
All instruments serviced
by



HASLER—TEL COMPANY, INC.
28 Vesey Street, New York 7, N. Y.
U.S. Distributors for Hasler Speed Indicators since 1919

For more information circle **35** on inquiry card.

new!

P-T-F
Digital Indicator

• another new digital systems component by BJ Electronics-Borg-Warner

• specifically engineered for use with BJ Vibrotron Digital Gages

1 Indicates measurement signals from remote Vibrotron digital sensing gages directly in numbers.

2 Pressure, temperature or flow measurements are indicated directly in absolute or percent full scale numbers.

3 Visual read-out is provided from 000 to 999 in steps of 0.1 for a percentage type indication allowing maximum utilization of digits.

4 May be used with printer or electric typewriter for permanent digital recording.

5 Supplementary memory feature... see below.

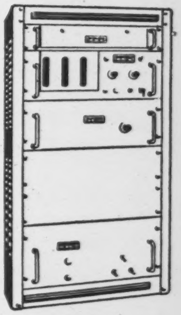
BJ VIBROTRON DIGITAL GAGE

The heart of BJ digital systems is the patented Vibrotron gage. This electronic sensing device utilizes a vibrating wire which is tuned by an element sensitive to pressure, temperature or flow. The Vibrotron gage generates its own precision measurement frequency signals which can be transmitted by radio link or direct wire without loss of accuracy.

BJ MEMORY FILE

This companion unit allows the BJ Digital Indicator read-out to be set to any desired base number (such as 000)... and retains this base as a digital constant.

Make your systems count! This new P-T-F Digital Indicator is one of a group of BJ digital systems building blocks engineered to indicate, record and control pressure, temperature or flow operations.



The P-T-F Digital Indicator and its auxiliary Memory File are designed for standard relay rack mount or can be individually cased.

For full information on these and other new BJ-Borg-Warner products, write for the special technical file "Make Your Systems Count."

BJ ELECTRONICS

BORG-WARNER CORPORATION

3300 Newport Boulevard • Santa Ana, California

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t/i progress report on silicon rectifiers

NEWEST ADVANCE . . . 1500 VOLT

single junction silicon rectifiers

1N543
1N544
980631
1S9086
1N543A
1N544A

PRODUCTS SHOWN ACTUAL SIZE

You can now obtain maximum rectifier miniaturization along with nearly *double* the operating voltage previously obtainable from silicon rectifiers – with new TI *single element* grown junction silicon rectifiers. This twofold advance – single element construction plus 1500 volt operating voltage – results in immediate extension of design limits in guided missile and other military applications. Also, these rectifiers are ideal for use in series for cathode ray tube and similar high voltage circuits.

TI miniaturized silicon rectifiers feature forward current ratings to 100 ma . . . have high mechanical reliability . . . and operate stably to 150° C. They require no filament power . . . no warm up time. Five production types give you a choice of axial-lead and stud-mounted half wave and plug-in full wave models.

All these devices in production and available now!

Also, for exacting circuit requirements, select from TI's line of 69 SILICON JUNCTION DIODES, including:

TI GENERAL PURPOSE	650 VOLTAGE REFERENCE
661 HIGH CONDUCTANCE	TI UNIFORM FORWARD CHARACTERISTIC

Write today for complete data!

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

★ ***See our exhibit at the Wescon Show***

For more information circle **37** on inquiry card.

New Plants and Mergers

ROYAL PRECISION CORP. has been formed by the General Precision Equipment Corp. and Royal McBee Corp. for the purpose of manufacturing and marketing of data processing equipment, including the LGP-30, now known as the Royal Precision Electronic Computer LGP-30.

MASON-NEILAN DIV. is now occupying its new plant and offices in Norwood, Mass.

DAYSTROM, INC., announces the formation of Daystrom International Div. to handle export sales of all Daystrom Companies.

PCA ELECTRONICS INC. moved into a new plant at 16799 Schoenborn St., Sepulveda, Calif. on August 1.

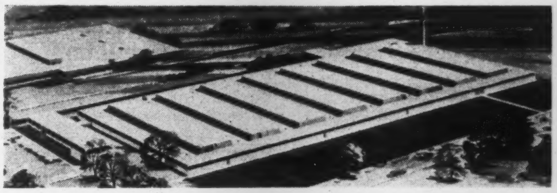
CONSOLIDATED ELECTRODYNAMICS CORP. has acquired Electronic Industries, Inc., of Burbank, Calif., maker of etched wiring boards and transistor circuitry.

RESEARCH APPLIANCE CO. announce purchase of a new, larger plant in Allison Park, Pa.

SUPERIOR TUBE CO. announces the creation of a Nuclear Products Div.

BURROUGHS CORP. announces acquisition of ElectroData Corp. which will now be ElectroData Div. of Burroughs Corp.

THE IMPERIAL BRASS MFG. CO., Chicago, has a new plant under construction in Niles, Ill.



POWERS REGULATOR CO. announces opening of a new branch office in Portland, Oregon.

McDANEL REFRACTORY PORCELAIN CO. Beaver Falls, Pa., is completing a $125,000 expansion program.

DATAMATIC CORP. announces construction under way for a two-story addition to plant facilities at Newton Highlands, Mass.

PIC DESIGN CORP. announces that Benrus Watch Co. has proposed to purchase PIC through an exchange of stock.

BARTON
on the move !
PLANT ONE
PLANT TWO
PLANT THREE
BARTON

Symbolic of BARTON'S service to industry and its rapid growth in the instrument and automation field, is its move to a new plant in Monterey Park, California. This modern, air-conditioned facility combines once again all operations under one roof for greater and more efficient production.

VISIT BARTON'S BOOTHS 419-420-421
ISA CONFERENCE & EXHIBIT—COLISEUM
NEW YORK CITY, SEPTEMBER 17-21, 1956

BARTON INSTRUMENT CORPORATION
INDUSTRIAL INSTRUMENTS
580 Monterey Pass Rd., Monterey Park, Calif.

For more information circle 33 on inquiry card.

PLANTS—CONTINUED

THE HICKOK ELECTRICAL INSTRUMENT CO. announces opening of a new branch office at 2585 Shattuck Ave., Berkeley, Calif.

SERVOMECHANISMS, INC., announces its Components Div. has changed its name to Mechatrol Div.

NRC EQUIPMENT CORP. announces new representatives; W. C. Davis & Assocs., Atlanta, Georgia, and Winnett Boyd, Ltd., Toronto, Ontario.

J & B MAGNETICS CO., La Habra, Calif., has been formed to manufacture custom transformers.

AIRBORNE INSTRUMENTS LAB., INC., Mineola, N. Y., and Compagnie Generale de Telegraphie Sans Fil, Paris, France, announce the formation of Intercontinental Electronics Corp. to mfr. and market in USA electronics products developed in France.

HYCON ELECTRONICS, INC., Pasadena, announces expansion of its engineering, production and sales facilities.

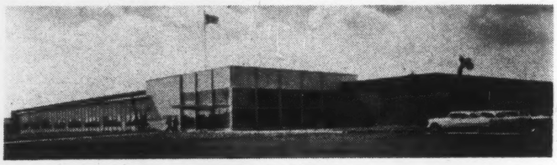
MULTI-AMP CORP. has moved its plant and offices to 465 Lehigh Ave., Union, N. J.

AMERICAN MACHINE & FOUNDRY CO. announces the Sterling Engineering Div. has been made a subsidiary of Potter & Brumfield, Inc.

TELEMETER MAGNETICS, INC., announces their new location is 2245 Pontius Ave., Los Angeles.

FEEDBACK CONTROLS, INC. has consolidated its Alexandria, Va., plant and its Cambridge, Mass., engineering office into a new facility in Waltham, Mass.

NATIONAL CASH REGISTER CO.'S Electronics Division has opened a new million-dollar research center in Hawthorne, Calif.



THE SAFETY CAR HEATING & LIGHTING CO., INC., New Haven, Conn., changed their name to Safety Industries, Inc., at their annual stockholders meeting in April. Recently the company acquired the Automatic Temperature Control Co. of Phila. and the Howe Scale Co.

LEAR, INC.'S Board Chairman, *William P. Lear*, announces that the Italian firm Officine Galileo di Milano s.p.a., Milan, has been licensed to build Lear gyro instruments to meet future Italian needs.

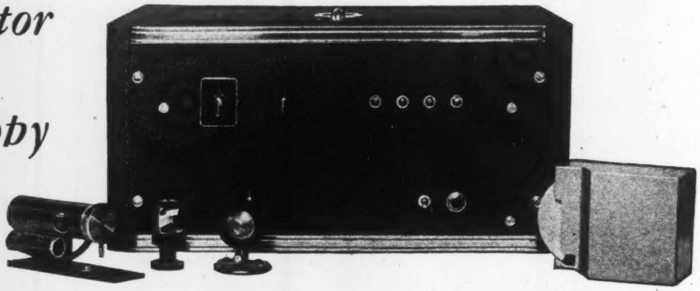
AUTONETICS DIV., North American Aviation, Inc., announces proposed construction of a two million dollar headquarters building to house manufacturing and development facilities and offices.

HALLIKAINEN INSTRUMENTS, Berkeley, Calif., announces near completion of its factory-expansion program designed to make available an increase of 150% over present facilities.

GENERAL ULTRASONICS CO., Hartford, Conn., announces moving to a new and enlarged plant at 67 Mulberry St., Hartford, Conn.

A Superior Detector
for
Infra-Red Spectroscopy

GOLAY
PNEUMATIC
DETECTOR



Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10⁻¹¹ watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.**
4. **Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.**

Write for EPLAB Bulletin
No. 10

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
2 SHEFFIELD AVENUE, NEWPORT, RHODE ISLAND, U.S.A.

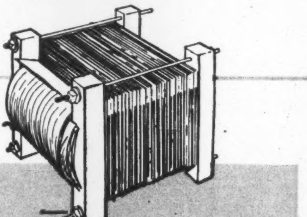
For more information circle **39** on inquiry card.

75 *years* 1881 1956 of Equipment and Systems Engineering

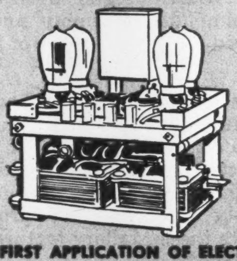
This year, Union Switch & Signal celebrates its seventy-fifth anniversary. It was back in May, 1881, that George Westinghouse, one of America's greatest inventors, organized The Union Switch and Signal Company to design and produce railway signal systems and apparatus.

Since then, Union Switch & Signal has made major contributions to the railroads and industrial control fields in the continual development of better equipment and systems.

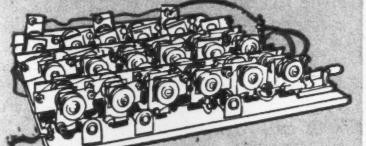
Today, Union Switch & Signal is rapidly branching out into fields where our vast experience in electronics can be put to use. A few of the latest engineering achievements and components are described here.



THE DEVELOPMENT OF THE TRANSFORMER. In 1885, Mr. Westinghouse and his engineers at Union Switch & Signal made intensive studies of a device brought from Europe called a secondary generator. Resulting from these studies was the design of the first practical transformer to be built in this country. This laid the foundation for modern high-voltage, A C power systems.



THE FIRST APPLICATION OF ELECTRONICS outside the field of communication. In 1916, vacuum tubes were used by Mr. L. V. Lewis and other Union Switch & Signal engineers in designing the first inductive automatic train control system. This marked the beginning of the widespread use of electronics in industry.



THE FIRST PRACTICAL SEMI-CONDUCTOR. The first copper-oxide rectifier was built in the Union Switch & Signal laboratories in 1920, under the direction of Dr. L. O. Grondahl. This dry-plate rectifier is recognized as the pioneer in the semi-conductor field which has broadened so much in recent years by the addition of new devices such as the transistor.

SYSTEMS

CENTRALIZED TRANSPORT CONTROL—With UNION Centralized Transport Control, fast and efficient movement of liquids and gases in pipelines is remotely controlled and indicated. Metering, alarm systems, and data handling are made part of the system.

GUIDED MISSILE GROUND HANDLING EQUIPMENT—Missile launcher vehicles, missile transport vehicles, and related electrical and electronic support equipment are manufactured by UNION for the TM-61 Martin "Matador."

FLIGHT SIMULATORS AND TRAINING AIDS—Jet aircraft flight simulators, mass-produced by UNION, realistically create flight situations. Pilot sits in an actual cockpit complete with controls and instruments. Over 10 tons of electronic equipment, mostly analog computers, is used in each simulator.

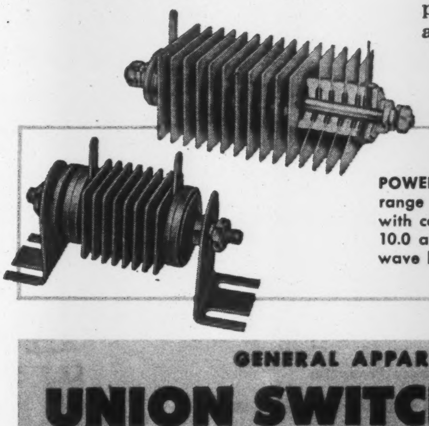
COMPONENTS

MINIATURE RELAYS—UNION AC and DC hermetically sealed miniature relays are recognized as "tops" in electronic and aviation equipment. They offer high shock, vibration and voltage breakdown rating, coupled with long life and reliability.

IMPULSE AND CARRIER EQUIPMENT FOR INDUSTRIAL CONTROL — UNION employs impulse, tone and carrier systems for remote control equipment designed for pipeline, TV elevator, furnace door and other control systems.

RECTIFIERS — UNION copper-oxide and selenium rectifiers, backed by more than 30 years' experience in the dry metallic, semi-conductor field, for commercial applications, offer the utmost in life and reliability. A new UNION development, the RECTALOY* rectifier, proved by models produced in pilot production, is expected to broaden the applications for this type of rectifier.

**Trade-mark*



POWER RECTIFIERS with solid stack assembly range in sizes from 1" x 1" to 5" x 6", and with convection cooling are rated from .80 to 10.0 amperes per cell on a single-phase full-wave bridge basis.

GENERAL APPARATUS SALES

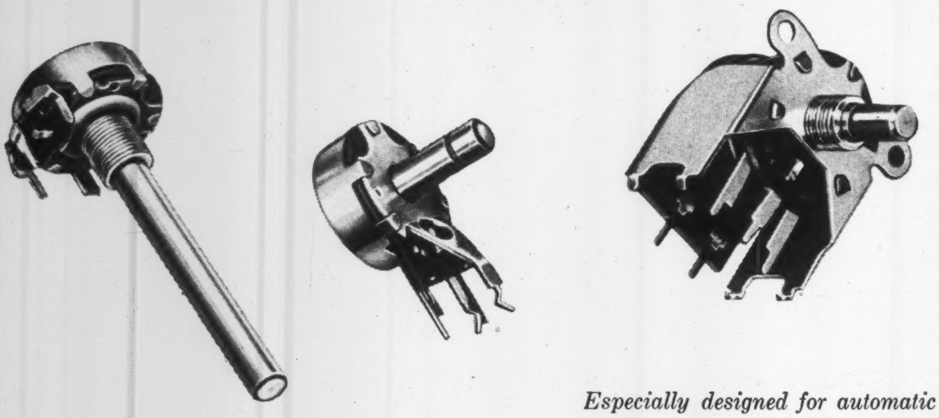
UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18 PENNSYLVANIA

For more information circle **40** on inquiry card.

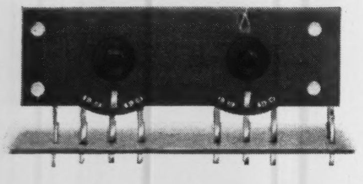
MALLORY



Especially designed for automatic assembly methods, this line of Mallory controls provides superior performance on printed circuit applications.

New Mallory Controls for Printed Circuits

ECONOMICAL STRIP TYPE CONTROLS FOR PRINTED CIRCUIT USE



This simplified series of controls, a Mallory "first", consist of resistance wafers attached directly to a phenolic panel, in single, dual and triple units. You save in installation cost, for multiple units can be mounted as easily as a conventional single. You save in component cost, too . . . for these Mallory controls give you multiple units at substantially lower price than that of a corresponding number of individual controls. Resistance values cover the range from 250 ohms to 10 megohms. Numerous adaptations available. Write to Mallory for technical data.

FOR your printed circuit designs, plan to take advantage of the simplified assembly and extra performance values offered by this new series of Mallory carbon controls.

A variety of designs is available. Included are self-supporting snap-in models for top of panel mounting . . . threaded bushing models . . . and types for mounting directly on the circuit panel. All are built with mounting lugs and terminals, precision-positioned for foolproof, fast assembly by automatic production machines. All incorporate these Mallory features:

High stability resistance element, made by special Mallory process, minimizes drift under severe humidity and temperature variations . . . gives long life.

Unusually low electrical noise.

New "floating ring" line switch, using a unique contact action, can be supplied on the new controls . . . far outlasts ordinary switches, gives clean, sharp make and break.

A complete selection of resistance values and tapers is available to match your circuit requirements. For complete data, write or call Mallory today.

Serving Industry with These Products:

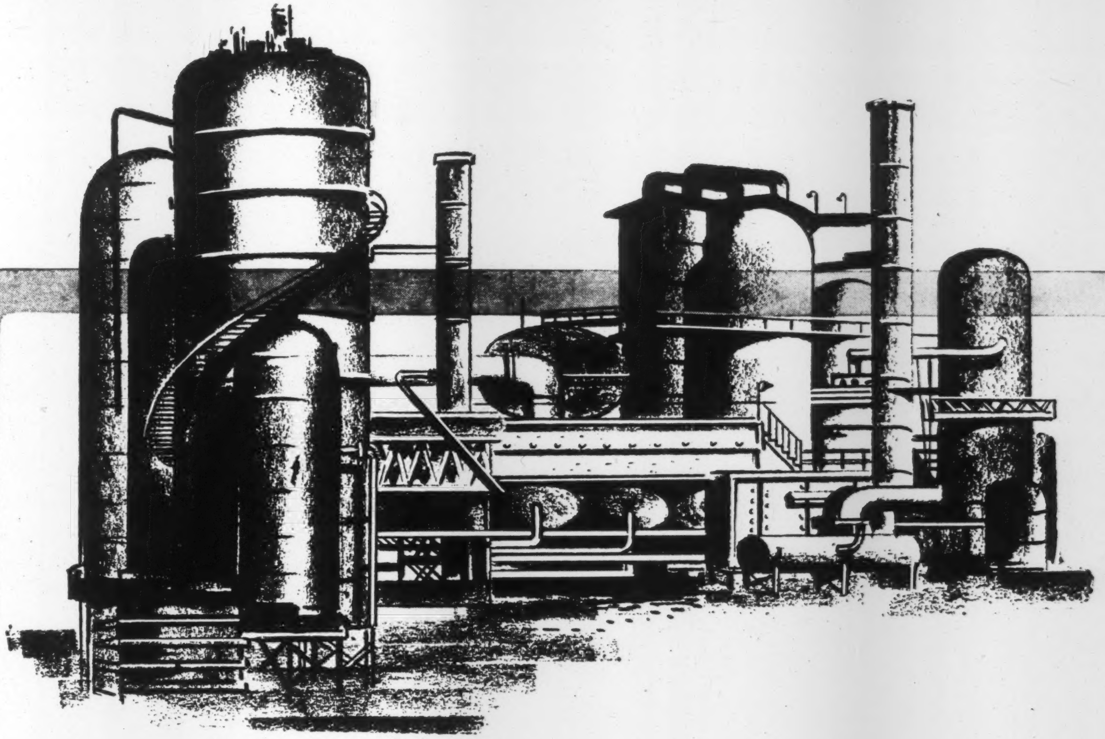
Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For more information circle **41** on inquiry card.

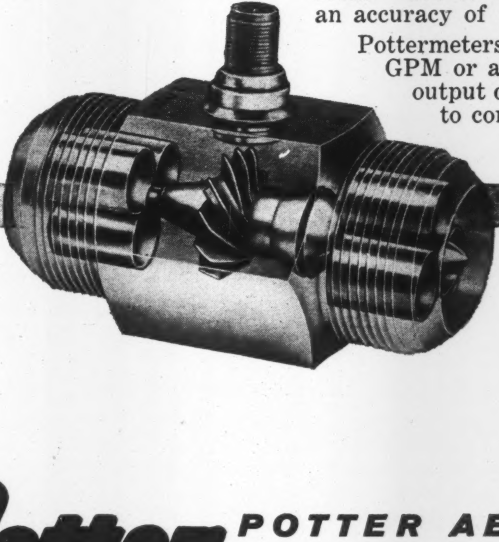


FOR VITAL FLOW CONTROL

WHETHER you're developing a new process or modernizing an old one—investigate the unique characteristics of the *bearingless Pottermeter.*

This electronic flowmeter—easily installed in any type of piping to operate at any angle, at any pressure and at temperatures from −450 to +1200°F, measures flow of any liquid with an accuracy of ±½ of 1%.

Pottermeters are available to measure flows as low as 0.07 GPM or as high as 3,000 GPM. The inherently linear output of the Pottermeter makes it ideal for systems to control either flow rate or total flow.



Find out how the bearingless "floating rotor" used in the Pottermeter can give you more precise flow measurement, longer trouble-free service life, and more accurate flow control.

Write for Bulletin PS-1

Potter

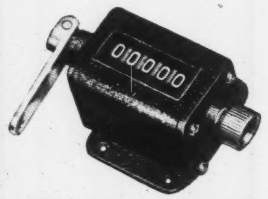
POTTER AERONAUTICAL COMPANY
Route 22 • Union, New Jersey • Phone MUrdock 6-3010
Makers of "Potter Engineered" products

For more information circle **42** on inquiry card.

See this "Show-Case" of
VEEDER-ROOT COUNTERS...
at your
Industrial Supply Distributor

Useful "facts-in-figures" on practically every machine, operation, system or process in industry can be supplied by Veeder-Root Counters for mechanical, electrical and manual operation. And now Veeder-Root Counters can be supplied from stock by certain leading Industrial Supply Distributors. Find out from your own distributor how they can add to the efficiency and *Count*rol of your plant operation. And if you are selling or designing equipment, contact Veeder-Root for engineering recommendations.

Insist on Standard
VEEDER-ROOT COUNTERS
from your Industrial Supply Distributor or write us on special problems

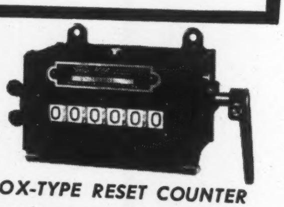


SMALL RESET COUNTER

A compact, rugged reset counter for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.

Dimensions: $1\frac{3}{4}$" long, $1\frac{19}{64}$" high, $1\frac{7}{16}$" wide

Speed: Up to 1000 counts per minute.



BOX-TYPE RESET COUNTER

For punch press installations, conveyors, metal-working equipment, die casting, plastic-molding, rivet, spring and wire machining, or any installation requiring a heavy duty counter.

Dimensions: $4\frac{1}{4}$" long, $2\frac{5}{32}$" high, $3\frac{3}{8}$" wide.

Speed: 500 counts per minute.

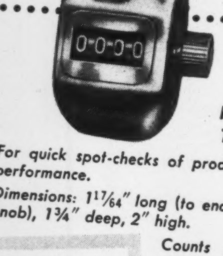
RESET MAGNETIC COUNTER

For remote indication of machine operation from plant to office.

Dimensions: $3\frac{15}{16}$" long, $2\frac{1}{2}$" high, $1\frac{5}{8}$" wide.

Speed: Up to 1000 counts per minute.

Coils: 110V-AC are standard. Other voltages are available. Panel mounting feature also available.

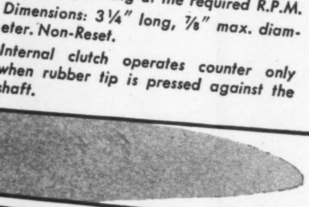


HAND TALLY

For quick spot-checks of production or performance.

Dimensions: $1\frac{17}{64}$" long (to end of reset knob), $1\frac{3}{4}$" deep, 2" high.

Counts one for each depression of the thumb lever, and resets to zero by a turn of the knob.



CLUTCH SPEED COUNTER

For checking to make sure that the machine is operating at the required R.P.M.

Dimensions: $3\frac{1}{4}$" long, $\frac{7}{8}$" max. diameter. Non-Reset.

Internal clutch operates counter only when rubber tip is pressed against the shaft.

Everyone Can Count on

VEEDER-ROOT

"The Name that Counts"

HARTFORD 2, CONN.

Stocked at Hartford 2, Conn. • New York 19, N. Y.
Greenville, S. C. • Chicago 6, Ill. • Montreal 2, Canada
Offices and Agents in Principal Cities

For more information circle **43** on inquiry card.

CONSOLIDATED ELECTRODYNAMICS CORP., Pasadena, announces appointment of *Hugh F. Colvin* as president, *John J. McDonald* as assistant director of the Systems Div., *Ware Myers* as personnel coordinator and *Joseph T. Johnston* as engineering representative.

H. F. Colvin
CEC

J. R. Bradburn
Burroughs

BURROUGHS CORP. announces appointment of *James R. Bradburn* as vice president of Burroughs and general manager of the new ElectroData Div.

BURROUGHS CORP., Detroit, Mich., announces appointment of *Richard J. Egger* as director of sales planning for the defense sales division.

G. L. Schwartz

K. R. Knoblauch

MINNEAPOLIS-HONEYWELL REGULATOR CO., Philadelphia, Penna., announces appointment of *George J. Schwartz* as vice president and general manager of Doelcam Div., and *K. Russell Knoblauch* as sales manager for the oil and chemical industries, Industrial Div.

People IN THE NEWS

FENWAL ELECTRONICS INC., Framingham, Mass., announces appointment of *Robert S. Goodyear* as President of the firm.

R. S. Goodyear
Fenwal

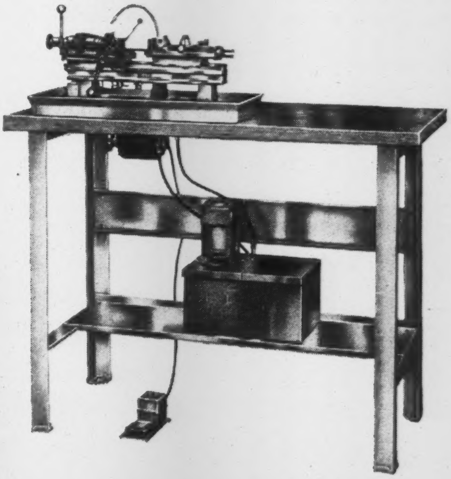
R. W. Stanton, Jr.
Conoflow

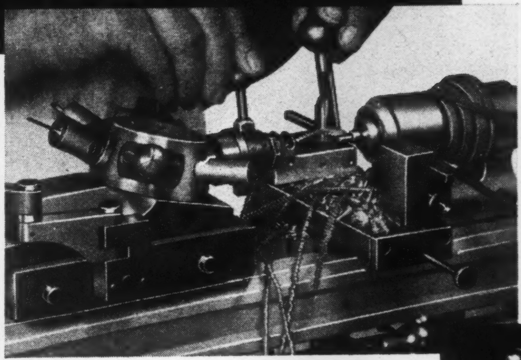
CONOFLOW CORP., Philadelphia, Pa., announces appointment of *Robert W. Stanton, Jr.*, as advertising manager.

CENTURY ELECTRONICS & INSTRUMENTS, INC., Tulsa, Okla., announces election of *T. A. Menhart* as President of the firm.

FOXBORO CO., Foxboro, Mass., announces appointment of *V. A. Pardo* as head of the Chemical Industries Sales Div., *E. N. Hayes*, manager of the Refinery Industries

YOU CAN PRODUCE SMALL INSTRUMENT PARTS
WITH MORE
ACCURACY · ECONOMY and SPEED





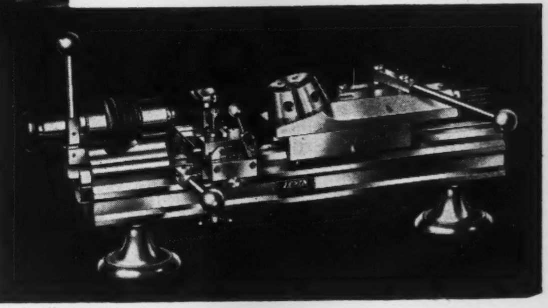
A small precision turret lathe for second operations and production of instrument parts. Available in two collet capacities, 5/16" or 3/16". The 6 position turret is self indexing and has hardened ways. Turret holes are 1/2" diameter. Turret travel 1-5/8".

LEVIN ® TURRET LATHES

The cross slide has a swivel slide at one end and a rigid tool block at the other. Lever collet closer provides quick opening and closing. A variety of turret tools with 1/2" shanks is available.

Send for catalog M describing complete line of instrument lathes, microdrilling equipment and accessories.

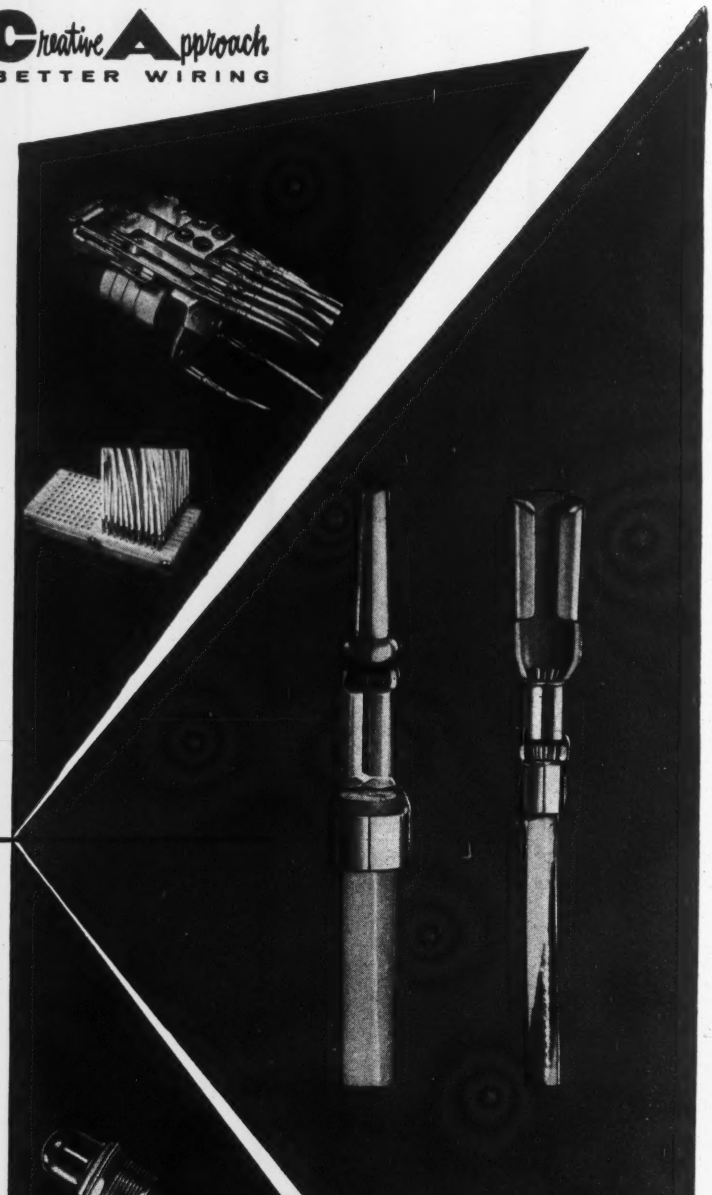
LOUIS LEVIN & SON, INC.
3610 South Broadway • Los Angeles 7, California



For more information circle 44 on inquiry card.

ask about Amp's Creative Approach
TO BETTER WIRING

More Confidence... Less Expense with A-MP® Taper Technique



A-MP Taper Pins, Taper Bloks, Taper Tips, Taper Tabs and Taper Tab Receptacles offer great freedom of circuit design and insure maximum electrical stability.

They cut material cost . . . cut labor cost . . . and reduce assembly time. Taper Technique is benefiting manufacturers of business machines, aircraft, guided missiles and electronic equipment.

You, too, can benefit by the A-MP Taper Technique. Consult your local A-MP salesman or write to Harrisburg.

©A-MP 1956

A-MP®

Aircraft-Marine Products, Inc.
General Office: Harrisburg, Pa.

A-MP of Canada, Ltd., Toronto, Canada • A-MP—Holland N.V., 's-Hertogenbosch, Holland
Aircraft-Marine Products (G.B.) Ltd., London, England • Societe A-MP de France, Courbevoie, Seine, France

For more information circle **45** on inquiry card.

Sales Division, and *J. M. Petrillo, R. C. Tamm, C. R. Fleming* and *J. W. Peirce* to sales promotion posts.

C. P. CLARE & CO., Chicago, Ill., announces appointment of *Thurman L. Sipp* as director of sales engineering and *Frank J. Wilmot* as assistant sales manager.

T. L. Sipp
Clare

F. K. Wilmot
Clare

BECKMAN INSTRUMENTS INC., Fullerton, Calif., announces addition of *William F. Gunning* and *J. Herbert Brown* to the new Data and Controls Systems Dept. Berkeley Div. announces appointment of *Joseph L. Hussey* as head of the Analog Computer Dept.

J. L. Hussey
Beckman

J. Kilmer
F & P

FISCHER & PORTER CO., Hatboro, Penna., announces appointment of *Marvin D. Weiss* as manager of the Analytical Div. of the Research Dept., *Vincent Matner* as chief product engineer and *James Kilmer* as advertising manager.

W. S. ROCKWELL CO., Fairfield, Conn., announces appointment of *Richard E. Love* as manager of the Valve Div.

BARKSDALE VALVES, Los Angeles 58, Calif., announces appointment of *Don Finlayson* to the Chicago office.

R. E. Love
Rockwell

D. J. Finlayson
Barksdale

P. D. Bezazian
Burton Browne

BURTON BROWNE ADV. AGENCY, Chicago, Ill., announces the 15th anniversary of *Paul D. Bezazian,* partner in the agency.

HYCON ELECTRONICS, INC., Pasadena, Calif., announces appointment of *E. J. Norman* as sales manager.

ZENITH OPTICAL LABORATORY, Copiague, L.I., N.Y., announces appointment of Commander *John D. Cassidy* as plant manager.

PERKIN ENGINEERING CORP., El Segundo, Calif., announces appointment of *Millard Leff* as district manager of the New York office and *George W. Mousel* as assistant manager of the sales department.

EPPLEY LABORATORY, Newport, R.I., announces appointment of *Andrew J. Drummond* as chief research physicist.

ALPA

World's Most Advanced 35mm Camera

For every industrial use . . .

Write for illustrated brichure IA-8

the ALL-IN-ONE
camera
with the ALL-IN-ONE
lens!

Startling innovation in the design of the MAKRO-KILAR 40mm f/3.5 lens lets you focus from infinity all the way down to 2"—without any accessories!

YOU CAN use semi-wideangle coverage to take in entire production lines—
YOU CAN include more in normal shots for identification photos, etc.—
YOU CAN copy blueprints, charts, texts, posters, etc. to large scale—
YOU CAN move way in for ultra-closeups, "lifesize" reproductions of tiny machined parts or test sections— . . . **ALL WITH ONE LENS!**

- No extension tubes, bellows, or supplementary lenses to buy. The unique focusing mount gives you all the extension you need.
- No extra lens shade to buy—it's built right into the mount!
- No extra finders or focusing guides to buy—the ALPA's brilliant through-the-lens focusing system gives you exact depth of field at any aperture, and eliminates parallax: you see exactly what you get with any lens, at any distance, under any circumstances!

And the ALPA is also the ideal camera for your personal use!

	Makro-Kilar E*	Makro-Kilar D**
ALPA 4 (straight reflex)	$259.	$284.
ALPA 5 (prism reflex)	$329.	$354.
ALPA 7 (prism & rangefinder)	$369.	$394.

*foc. from inf. to 4", **foc. from inf. to 2"

Also: Interchangeable 90mm f/2.8 Makro-Kilar, foc. from inf. to 8", $266.45

Karl HEITZ Inc.
HIGH PRECISION PHOTO EQUIPMENT
Binoculars • Microscopes • Instruments
480 LEXINGTON, NEW YORK 17, Eldorado 5-5691

For more information circle 46 on inquiry card.

OFFICE AUTOMATION
conference for
SENIOR EXECUTIVES
New Yorker Hotel

Co-sponsored by
FORDHAM UNIVERSITY SCHOOL OF BUSINESS
and the
THIRD INTERNATIONAL AUTOMATION EXPOSITION
November 26, 27

- Managed by GORDEN L. MATTSON, office automation consultant and director of the first conference.
- Objective: to provide top management with information to guide them in making use of automation in data processing, etc.
- 8 sessions.

Write: RICHARD RIMBACH ASSOCIATES, INC.
Room 359, 525 Lexington Avenue
New York 17, New York

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AIR SPEED
ACCELERATION
PRESSURE SWITCHING
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Potentiometer type transducers for use at temperatures between —60° C. and +120° C.

Designs available permit single or multiple range linear output from non-linear input function, and operation over wide ranges of environmental conditions.

Designs available for operation to 160° C.

Special instruments for use with corrosive oxidants and fuels are available.

Specifications available on request.

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INSTRUMENTS, INC.
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NEW YORK 7, N. Y.

For more information circle 47 on inquiry card.

INSTRUMENTS and AUTOMATION Events

For other computer Events see page 1571

August 22-Sept. 1
23rd Annual (British) National Radio Show sponsored by Radio and Electronic Component Manufacturers Federation, Earls Court, London, England.

August 27-29
11th annual meeting of Association for Computing Machinery at Westwood Campus, University of Calif., Los Angeles, Calif. For information write Assoc. for Computing Machinery, Box 3251, Olympic Sta., Beverly Hills, Calif.

August 27-31
7th Annual Infrared Spectroscopy Institute, Fisk University, Nashville, Tenn.

September
8th International Congress for the History of Science, Milan or Florence, Italy. For information write Pierre Sergescu, Secretary of Union, 7 Rue Daubenton, Paris 5e, France, or G. Ucelli, IUHS, Via Cappuccio 7, Milan, Italy.

September 5-13
9th International Congress of Applied Mechanics, University of Brussels, Brussels, Belgium. For information write Secretary, The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

September 9-12
National Meeting of American Institute of Chemical Engineers, William Penn Hotel, Pittsburgh, Pa. For information write American Institute of Chemical Engineers, 25 W. 45th St., New York 36, N. Y.

September 9-16
15th International Congress of Pure and Applied Chemistry, International Union of Pure and Applied Chemistry, Lisbon, Portugal.

September 10-12
Fall Meeting of American Society of Mechanical Engineers, Cosmopolitan Hotel, Denver, Colo. For information write American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

September 10-12
Information Theory Symposium, sponsored by Institute of Radio Engineers on campus of Massachusetts Institute of Technology, Cambridge, Mass.

September 10-17
Symposium on Reliable Electrical Connections sponsored by RETMA on campus of University of Pennsylvania, Philadelphia. For information write RETMA Engineering Dept., 11 W. 42nd St., New York 36, N. Y.

September 14
International Conference on Fatigue of Metals, sponsored by the Institution of Mechanical Engineers, London, England. For information write, Secretary, Institution of Mechanical Engrs., 1 Birdcage Walk, London S.W. 1, England.

September 15-23
4th International Instruments and Measurements Conference and Exhibition organized by the Royal Academy of Engineering Sciences and the Swedish Association of Technical Physicists, will be held in Stockholm, Sweden. For information write Sven Malstorm, P.O., Box 12035, Stockholm 12, Sweden.

September 16-21
130th National Meeting of the American Chemical Society, Atlantic City, N. J.

September 16-22
2nd Pacific Area National Meeting of the American Society for Testing Materials, Statler Hotel, Los Angeles, Calif.

Sept. 17-21
11th Annual Instrument Society of America Conference and Exhibit, New York Coliseum, New York, N. Y. For information write William H. Kushnick, ISA, Granite Bldg., 313 Sixth Ave., Pittsburgh 22, Pa.

September 20-21
IRE Professional Group on Nuclear Science 3rd Annual Meeting, Mellon Institute Auditorium, Pittsburgh, Pa.

September 20-22
3rd Annual Meeting of IRE Professional Group on Nuclear Science, Mellon Institute and Hotel Webster Hall, Pittsburgh, Pa.

September 23-26
Petroleum-Mechanical Engineering Conference, sponsored by American Society of Mechanical Engineers, Conrad Hilton Hotel, Dallas, Texas.

September 24-25
Industrial Electronics Conference, sponsored by Institute of Radio Engineers and American Institute of Electrical Engineers, Hotel Manger, Cleveland, Ohio.

September 24-28
Joint committee for Automatic Control of German Association of Electronic Engineers, (VDE) and German Engineers Society (VDI) Conference on Automatic Controls, Heidelburg Germany. For information write Verein Deutscher Electrotechniker (VDE) Osthofenplatz 6, Frankfurt 2/main, West Germany.

September 24-28

Trade Fair of Atomic Industry, sponsored by Atomic Industrial Forum, Inc., Navy Pier, Chicago, Illinois. Conference will be held at Morrison Hotel on September 25-27. For information write Atomic Industrial Forum, Inc., Exhibit Dept., 260 Madison Ave., New York 16, N. Y.

September 25-28

American Roentgen Ray Society Commercial Exhibit, Statler Hotel, Los Angeles.

September 30-October 2

Fall convention and Co-Exhibit of American Congress on Surveying and Mapping and American Society of Photogrammetry, Shirley-Savoy Hotel, Denver, Colo.

September 26-29

Convention of Audio Engineering Society in participation with N. Y. High Fidelity Show, sponsored by Institute of High Fidelity Manufactures, Inc., New York Trade Show Bldg., N. Y.

October 1-3

National Electronics Conference and Exhibition, Hotel Sherman, Chicago, Ill., For information write G. Hok, Program Committee Chairman, University of Michigan, Ann Arbor, Mich.

October 1-3

Canadian Institute of Radio Engineers Convention and Exposition, Automotive Bldg., Canadian National Exhibition Pk., Toronto, Canada.

October 1-5

Fall General Meeting of American Institute of Electrical Engineers, Morrison Hotel, Chicago, Illinois.

October 3-4

11th National TAPPI Plastics-Paper Conference, Institute of Paper Chemistry, Appleton, Wisc.

October 8-10

Second National Symposium on Aeronautical Communications, Hotel Utica, Utica, N. Y.

October 16-18

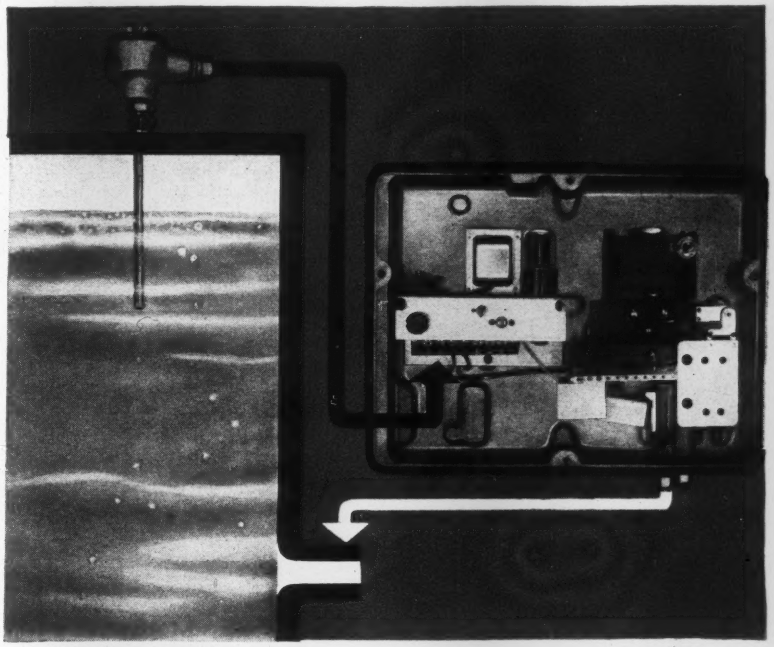
Conference & Exhibits on Magnetism & Magnetic Materials, sponsored by AIEE, IRE, APS, AIMME, Hotel Statler, Boston, Mass. For more information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Penna.

November 26-30

Third International Automation Exposition, New York Trade Show Building, 500 8th Ave., New York, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Penna.

NEW PNEUTRONIC* LEVEL CONTROL

brings speed and simplicity to Pneumatic Control



The new Fielden Pneutronic Level Control now provides proportioning pneumatic control without the disadvantages of mechanical systems. Pneutronic Level Control integrates electronic and pneumatic units in a null-balance system for simple, dependable level control.

Electronically, the Pneutronic Level Control features the versatile electrical capacitance method of measurement. As a result, it can be used with a simply-designed probe to detect minute changes in the level of any liquid, powder, or granular solid—conducting or non-conducting. The resulting change in capacitance changes output air pressure *directly*, and this output air then feeds back to balance the electronic circuit *directly*.

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PNEUTRONIC LEVEL CONTROL FEATURES

- Null-Balance System
- Only one radio tube
- Control pressure 3 to 15 psi
- No moving parts in vessel
- Controls water level up to 1½" span, hydrocarbons up to 8"

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☐ TELSTOR Continuous Level Indicator
☐ TEKTOLOG Recorder-Controller
☐ Fielden RF Capacitance Null-Balance Recorder

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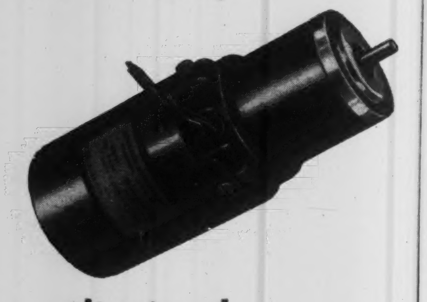
COMPANY______________ ADDRESS______________
CITY______________ ZONE______ STATE______________

For more information circle 48 on inquiry card.

versatility



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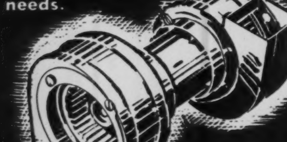
Advanced design concepts call for components to be conceived, developed, tested and proven with new and critical end applications in view. Every unit in the IMC line of AC and DC subfractional, servo and gear motors, fans, blowers and dynamotors is built for widest diversity in final use. The motor segment of the IMC line best typifies the flexibility of the entire catalog. Both fan-cooled and non-cooled units in horsepower ratings from 1/1000 to 1/10 are available immediately, with a variety of gear ratio options depending on specific needs.



IMC's blowers are found in combination with the company's motors, in an impressive array of industrial and military equipment. Standard IMC motor-blower units are readily adaptable for high ambient temperature operation, and are impregnated for protection in humid atmospheric situations.

Full engineering specifications on all units in the line are available on request.

Induction Motors Corp.

570 Main St., Westbury, L. I., N. Y.
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For more information circle 49 on inquiry card.

INSTRUMENTS and AUTOMATION Books

Office Automation; Integrated and Electronic Data Processing, by R. Hunt Brown. c1955. Automation Consultants, Inc., New York 18, N.Y. 283 p., loose-leaf binder. $12.50. 11½ in. Non-technical work for the business man, intended to indicate existing applications and suggest new uses. Kept up to date by annual service charge of $25.

Proceedings of the Symposium on Printed Circuits, Sponsored by the Engineering Department of the Radio-Electronics-Television Manufacturers Association. [1955.] Engineering Publishers, Box 1151, New York 1, N.Y. 122p. unbound $5. 11 in. Papers, with discussion, attempting to cover all methods of printed circuitry now in commercial use.

Instrumentation; Government-owned Inventions Available for License. n.d. U.S. Government Printing Office, Washington 25, D.C. 65p. Unbound. $2. 10¼ in. (Patent Abstracts, no. 1.) Cover title. Lists 775 patents active on December 31, 1953.

Physical Mathematics, by Chester H. Page. [c1955.] D. Van Nostrand Co., Princeton, N.J. 329p. $7.50. 9¼ in. Mathematical methods of physics explained in terms of physical interpretation, extension by intuition, and theoretical demonstration.

Handbook of Scientific Instruments and Apparatus, 1955. [1955.] Physical Society, Prince Consort Road, London, S.W.7, England. 286 + 80p. 10½ in. Catalogue of exhibits of scientific apparatus in connection with the Physical Society's 39th Exhibition.

Symposium on Fluorescent X-ray Spectrographic Analysis. [c1954.] American Society for Testing Materials, Philadelphia 3, Pa. 68p., unbound. $1.75. 9 in. (Special Technical Publication, no. 157.) Excitation of elements in the specimen by x-rays of short wavelength affords the basis for a method of quantitative analysis.

Mechanisms, by Joseph Stiles Beggs. 1955. McGraw Hill Book Co., New York 36, N.Y. 418p. $6.50. 9¼ in. Text for advanced courses in kinematics. Begins by pointing out the dual nature of mechanical design (the choice of a mechanical movement, and the design of the machine members) and the fact that these two problems affect each other. Includes a collection of mechanical movements.

Magnetic Control of Industrial Motors, by Gerhart W. Heumann. Ed.2. 1954. John Wiley & Sons, New York 16, N.Y. 714 p. $9.50. 9¼ in. On the application of control to specific jobs in industry. Not concerned with switchgear, and deals with electronic control in only a single chapter intended to familiarize the reader with electronic devices commonly used in conjunction with magnetic control.

Vacuum Symposium. Transactions, 1954. 1955. Committee on Vacuum Techniques, Boston 9, Mass. 147p. $10. 11¼ in. Contains 34 technical papers on equipment and instrumentation, processes, and applications. A valuable feature is a report on recommended standard nomenclature, and a glossary with terms completely defined.

Instrumental Methods of Chemical Analysis, by Galen W. Ewing. 1954. McGraw-Hill Book Co., New York 36, N.Y. 434p. $6.50. 9¼ in. Recognizing the increasing use of elaborate instruments in industrial laboratories, this text is intended for training of upper-class undergraduates and first-year graduate students. Pre-supposes a year of physics and an introductory course in quantitative analysis.

Frequency-Response Symposium. [1953?] American Society of Mechanical Engineers, New York 18, N.Y. 11¼ in. A set of 16 papers, by various authors, covering major aspects of the frequency response approach. Papers separately paged and no price indicated. To be published later, with discussion and additional material, under the title "Theory and Practice of Frequency Response."

Frequency Modulation, edited by Alexander Schure. [c1955.] John F. Rider, New York 13, N.Y. 45p., unbound. 90c. 8½ in. Presents fundamentals. Includes non-mathematical explanation of phase modulation.

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Pyrometer Engineers - Buyers - Plant Executives

Are you attending the I.S.A. Convention?

The worlds largest manufacturer of Pyrometer and Thermocouple Extension Lead Wire invites you to attend a GRANDE ENTERTAINMENT at the *Hotel Roosevelt Grand Ball Room*

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2 BIG NIGHTS Tuesday, Sept. 18 and Thursday, Sept. 20—9 p.m. till!

★ See Our Big Paris Floor Show—"CHERIE DE PAREE".

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★ Your caricature in folder as a souvenir.

★ Beautiful girls—Side attractions.

NOTE: Although we engaged the largest ballroom in New York City's Roosevelt Hotel and while we would like to have all our guests attend both nights as we have always done in the past, this may be impossible this year because of New York City's fire law limiting occupancy of ballroom: therefore, when writing for invitations please advise which night you prefer, should we be unable to accommodate you both nights. Or, visit us at Booth 225-A, NEW YORK COLLISEUM for invitations possibly available for additional night.

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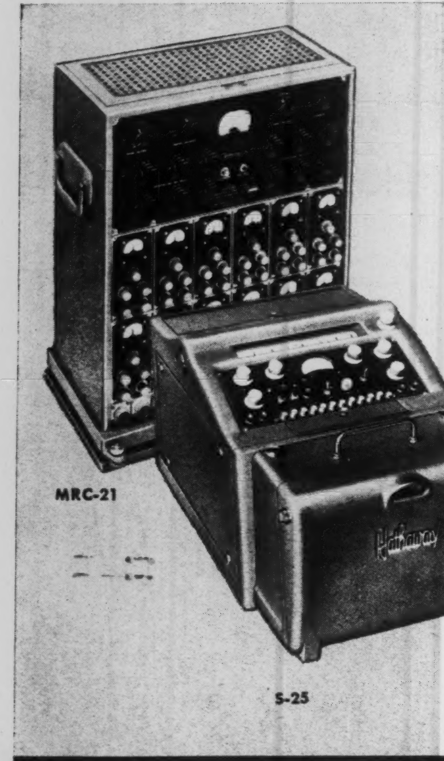
Worlds largest manufacturer of Pyrometer and Thermocouple Extension Lead Wire.

WE OPERATE OUR OWN WIRE INSULATING MILLS • LARGE SUPPLY CONTRACTS OUR SPECIALTY

For more information circle **50** on inquiry card.



The "perfect pair" for
DYNAMIC ANALYSIS

The new Hathaway S-25 oscillograph—with push-button chart speed selector, remote control features—and the Hathaway MRC-21 strain gage-transducer control unit—complete with automatic calibration of all channels—are the "perfect pair" for recording dynamic phenomena. Adaptable to rack-mounting.

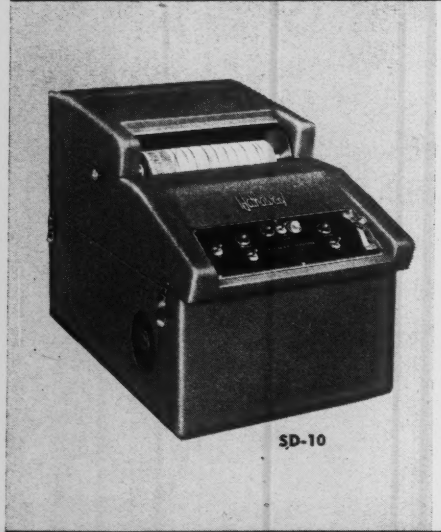
SPECIFICATIONS

S-25 Channels: to 36 **Chart Speeds:** 1/16 to 160 in/sec, 12 steps **Chart Speed Change:** Speeds selected by push buttons; electric transmission **Chart Size:** 8 in. x 300 ft. **Writing Rate:** 30,000 in/sec **Timing Lines:** 1, 1/10, 1/100 or 1/1000 sec. intervals.

Write for Bulletin 1-2-H

MRC-21 Channels: 6, 8 or 12, complete in one unit **Interchangeable Amplifiers:** Carrier and wide-band **Low Noise Level:** Less than 1/10 microinches/in **Output Current Swing:** ±80 ma. **Frequency Range:** 0 to 6000 cps.

Write for Bulletin 4-2-H



Supplement the "perfect pair" with
NEW SD-10 RECORD DEVELOPER

Benefit from the convenience of the "perfect pair" by processing S-25 records on the spot—immediately after they are recorded in the laboratory or in the field. Self-threading feature eliminates need for leaders or manual threading.

SPECIFICATIONS

SD-10 Chart Transport System: Continuous chain carries chart; no leaders or manual threading required **Capacity:** chart width to 12 in.; chart lengths to 250 ft. of standard base paper or 400 ft. of thin base paper **Chart Transportation Speed:** 1 to 10 feet per minute **Temperature Control:** Solutions maintained at 100°F **Size:** Length—27 in. Height—18½ in. Width—16 in. **Weight:** 110 lbs. dry

Write for Bulletin 3-30-H

SEE US . . . at the I.S.A. Show
New York, Sept. 17-21

Hathaway Instrument Division
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NOW!
A BRAND-NEW CONCEPT IN FLOW TOTALIZING!
FOXBORO
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. . . THE NEW FOXBORO PNEUMATIC *FLYBALL* INTEGRATOR

Inherently Accurate!

- Eliminates Inaccurate "Spot Check" Counting!
  Continuous integration assures highest precision.
- Eliminates Cam and Linkage Errors!
  Unique design balances differential pressure signal directly against centrifugal force.
- Eliminates Calculations!
  Automatically extracts square root — shows totals in desired units.
- Eliminates Fire and Explosion Hazards!
  Simple, all-pneumatic operation requires no electric motors, wires, or contacts.

Now you can integrate the flow of all process fluids or plant services *continuously* . . . with new accuracy . . . complete safety! The unique new, all-pneumatic Foxboro Flyball Integrator completely eliminates intermittent counting and fire hazard. Its simple, force-balance operation utilizes the 3-15 psi air signal from any differential-pressure flow transmitter. This signal is *continuously* balanced against the "flyball" force of the instrument's pneumatically-driven turbine. The square root function is automatically extracted . . . you read flow totals *directly*.

The Flyball Integrator mounts at the point of measurement or on a panel hundreds of feet away. Response and accuracy are completely unaffected by ambient temperature changes or pressure changes in turbine air supply. Ideal solution to all plant fluids accounting and in-process inventory checking. Write for complete details. The Foxboro Company, 468 Norfolk Street, Foxboro, Mass.

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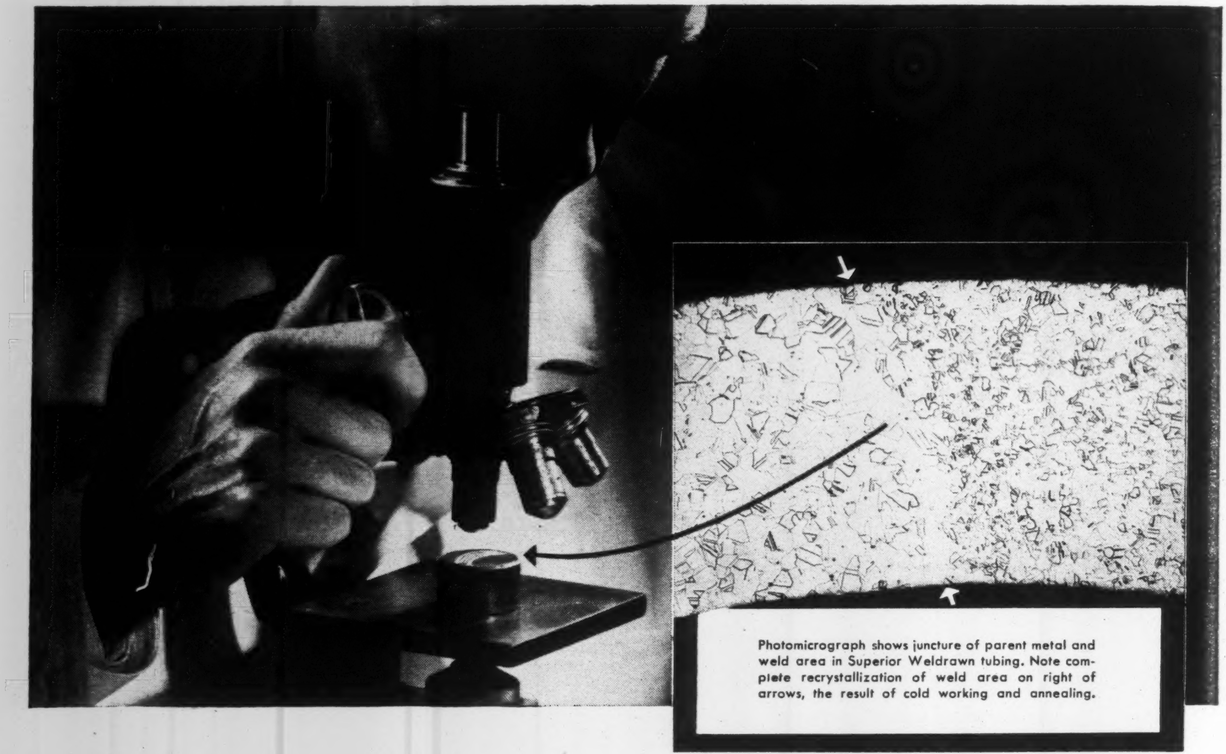
FIRST IN FLOW

For more information circle **52** on inquiry card.

Weldrawn® Tubing by Superior



Photomicrograph shows juncture of parent metal and weld area in Superior Weldrawn tubing. Note complete recrystallization of weld area on right of arrows, the result of cold working and annealing.

So perfect the bead actually vanishes!

Here's how to cut tubing costs up to 50%

Specify Superior Weldrawn. You get quality approaching that of seamless, at savings as high as 50%! Unlike other welded tubing, Weldrawn is offered in *any* of the intermediate sizes—made possible because of the redrawing after welding.

"Weldrawn" Means—

This is a tubing far superior to ordinary welded tubing for many applications requiring forming, machining and corrosion resistance. After welding, it undergoes alternate cold drawing and annealing.

The weld area recrystallizes (see photo above), acquiring mechanical properties equivalent to those of the parent metal. The bead actually vanishes!

Costs Are Low

Weldrawn tubing is produced in 18 different analyses, in a wide variety of sizes. Cost savings are 10 to 20%. In certain materials you save up to 50%!

Quality Is High

In Weldrawn you get tubing with highly uniform mechanical properties throughout, and clean, smooth, bright ID and OD surfaces. Because no filler or flux is used during welding, the corrosion resistance of the weld area is equal to that of the parent metal. And by repeated redrawing and annealing after welding, any possible faults or defects in the weld are eliminated.

Specify Superior

In addition to Weldrawn tubing, we also offer a wide variety of analyses and sizes in Seamless grade. So for the finest in small tubing, always specify Superior.

Whatever your problems in small tubing, Superior can help you. For additional information on Weldrawn, write for Data Memorandum No. 2. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses available in .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

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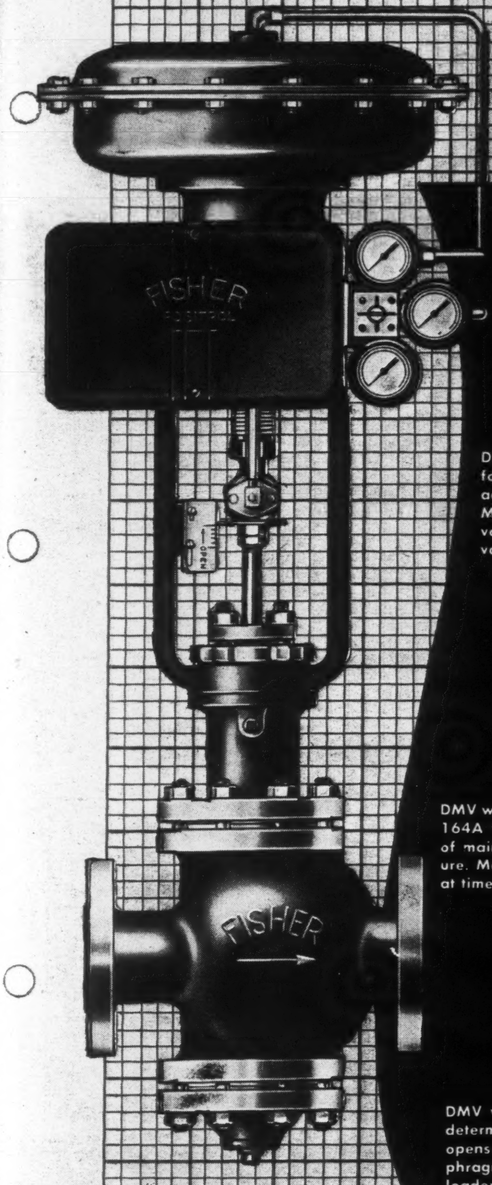
FISHER®

THE ANSWER TO YOUR *Control Problem*

Built for your specific requirements, Fisher Diaphragm Motor Valves are manufactured to handle pressure conditions up to 30,000 pounds, for high pressure drops and are available in metals for highly corrosive service and alloys for high temperature work.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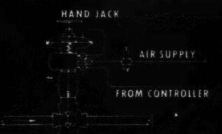
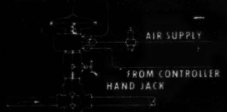
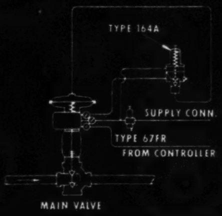
TYPICAL EXAMPLES OF FISHER DIAPHRAGM MOTOR VALVE WIDE RANGE ADAPTABILITY


HAND JACK
AIR SUPPLY
FROM CONTROLLER

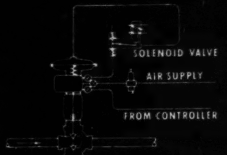
DMV with Hand Jack Operator. Allows for manual operation against spring action. Limits travel of valve. Example—Maximum opening in spring opened valve. Minimum closing in spring closed valve.


AIR SUPPLY
FROM CONTROLLER
HAND JACK

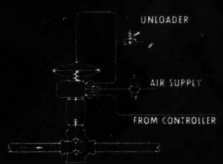
DMV with Continuously Connected Handwheel. Operator can open or close valve against controller action. Can operate valve manually if operating medium fails. Can set maximum opening or minimum closing of inner valve.


TYPE 164A
SUPPLY CONN.
TYPE 67FR
FROM CONTROLLER
MAIN VALVE

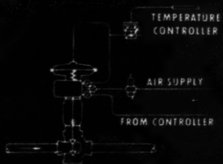
DMV with Air Lock-up system using Type 164A to close air circuit to diaphragm of main valve in case of plant air failure. Main valve will be held in position at time of supply pressure failure.


SOLENOID VALVE
AIR SUPPLY
FROM CONTROLLER

DMV with Remotely Actuated Electric Solenoid Trip Out. Valve may be fully opened or closed by unloading operating pressure from diaphragm by solenoid operation. Solenoid is actuated from manual switch or an electric tie-in circuit.


UNLOADER
AIR SUPPLY
FROM CONTROLLER

DMV with Air Cut-out Feature. At predetermined pressure setting, unloader opens and bleeds pressure off diaphragm to keep main valve open. Unloader orifice is larger than controller orifice so main valve remains open. Operation restored by putting thumb over open end of unloader.


TEMPERATURE CONTROLLER
AIR SUPPLY
FROM CONTROLLER

DMV with Auxiliary Controller Override. An auxiliary controller, such as temperature, placed in operating air line to diaphragm—can over-ride action of main control function by unloading diaphragm and taking over functional operation of DMV.

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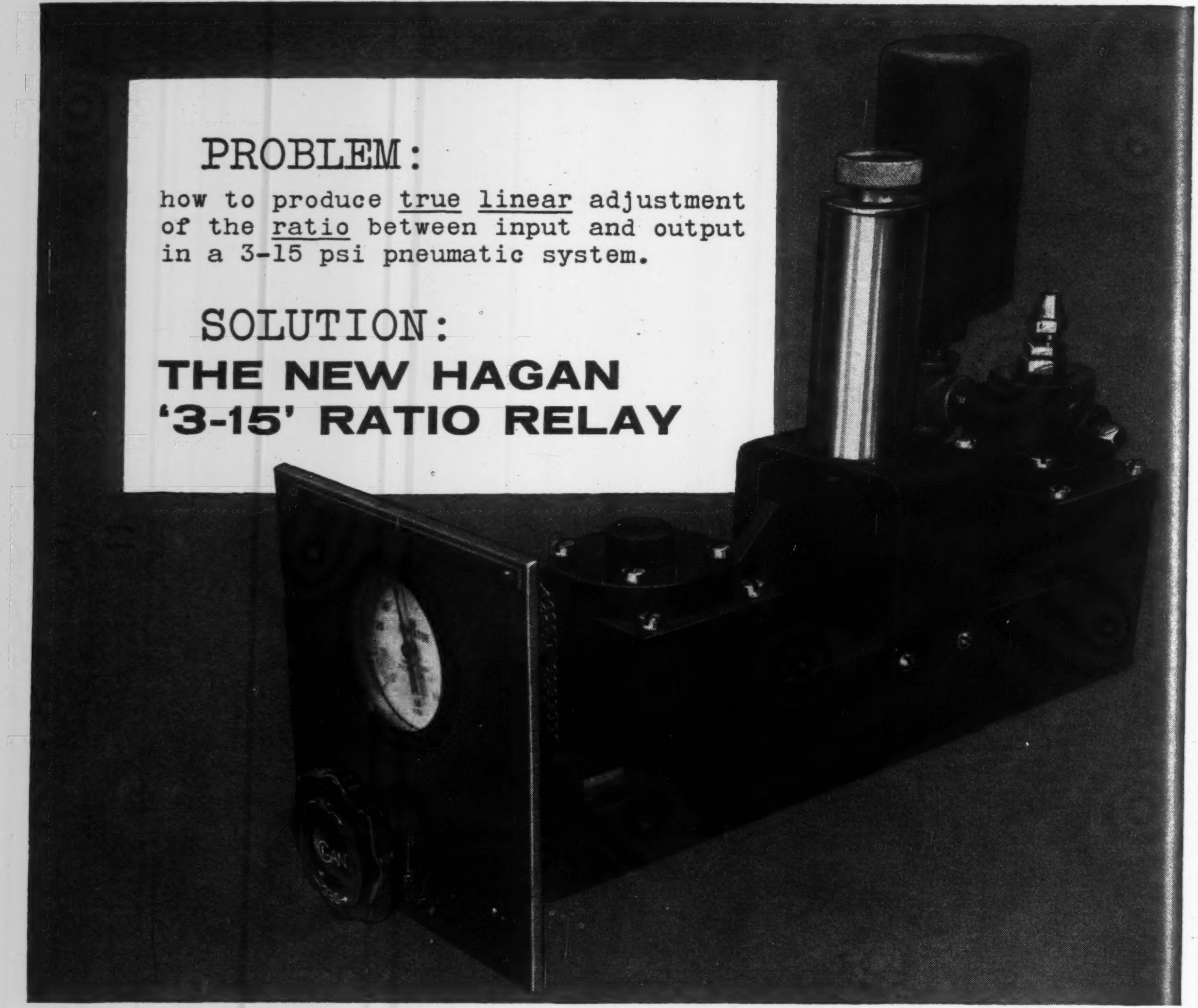

PROBLEM:

how to produce true linear adjustment of the ratio between input and output in a 3-15 psi pneumatic system.

SOLUTION:

THE NEW HAGAN '3-15' RATIO RELAY

This unique Hagan device fills a long felt need in pneumatic process control systems for a relay which will permit the operator to adjust the *ratio* between input and output signals.

Rugged and reliable, and requiring small space, the Hagan Model '3-15' Ratio Relay produces a true linear proportional change in the output signal. Designed primarily for use with 3-15 psig signals, the '3-15' is easily adjusted to change the minimum input and output bias values to any point between zero and six psig. The actual maximum input and output signals may be any value up to 20 psig.

The Hagan '3-15' is ideally suited for any process control systems such as fuel to air ratio in combustion processes, ratio of gases in gas mixing or in the proportional feeding of chemicals. See your Hagan engineer, or write for full details. Ask for Specification Sheet SP4315.

HAGAN MODEL '3-15' RATIO RELAY

True ratioing around 3 psig input
Compatible with any signal system whose range is between 0 and 20 psig
Simple means for altering suppressed scale setting, if desired
Mounting Plate dimensions—6⅜″ x 6⅜″
Input range—0-20 psig
Output range—0-20 psig
Minimum Ratio setting—0.3 to 1
Maximum Ratio setting—3.75 to 1
Suppressed Scale Range (adjustable)—0-6 psig

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HAGAN BUILDING, PITTSBURGH 30, PA.

Systems and Components for: Process Control, Metallurgical Furnace Control, Boiler Combustion Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

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INSTRUMENT & APPARATUS NEWS

September-October 1956

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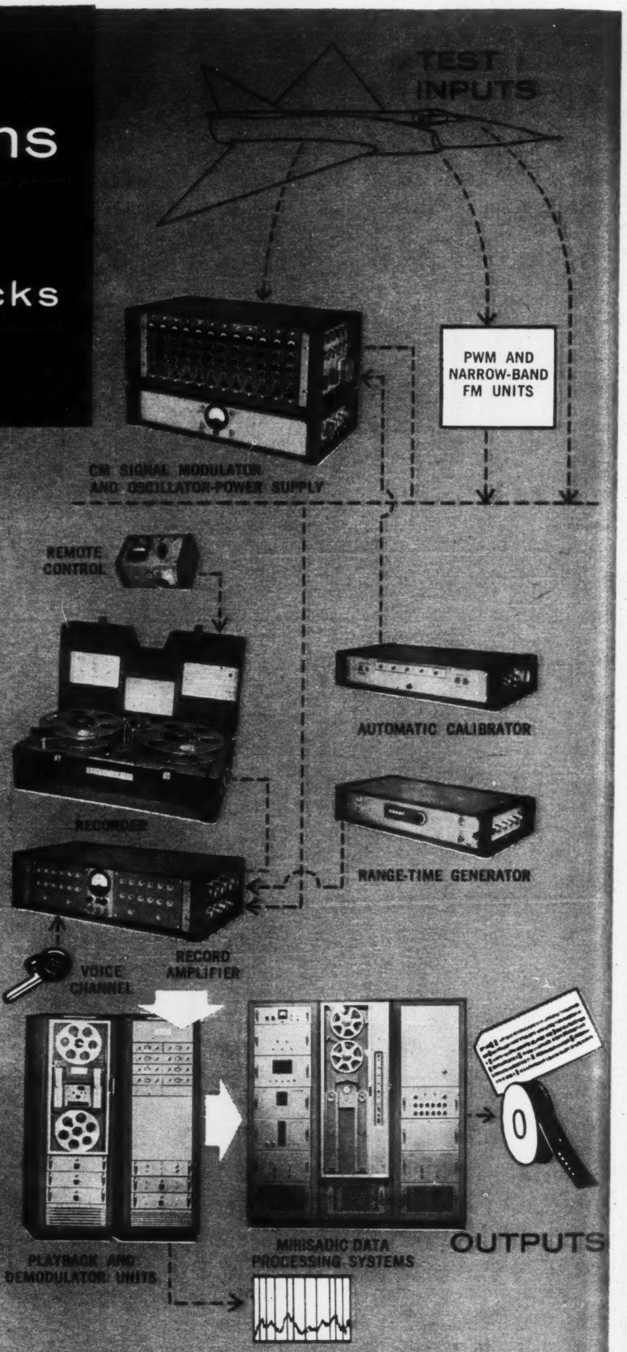
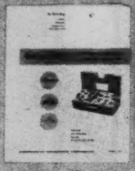
...the total answer to flight-test bottlenecks


TEST INPUTS
PWM AND NARROW-BAND FM UNITS
CM SIGNAL MODULATOR AND OSCILLATOR-POWER SUPPLY
REMOTE CONTROL
AUTOMATIC CALIBRATOR
RECORDER
RANGE-TIME GENERATOR
VOICE CHANNEL
RECORD AMPLIFIER
PLAYBACK AND DEMODULATOR UNITS
MILLISADIC DATA PROCESSING SYSTEMS
OUTPUTS

Consolidated's long-standing leadership in flight-test instrumentation includes the pioneering of the "systems" approach—the designing of instrumentation for the ~~Total~~ *Answer* rather than just components. "Test Variables to Digits" is literally true as a description of CEC's products and experience.

From CEC's Transducer Division have come some of today's most widely used devices for *sensing* the parameters of supersonic flight. DataTape, shown at the right, was developed specifically for the problems of flight-test data *handling*, is a coordinated family of instruments ready to serve as a proven nucleus for a wide variety of data-processing systems. For the vital step of *digitizing* test data, CEC developed the SADIC and MilliSADIC group of instruments and systems—today's most comprehensive, *proven* line of analog-to-digital data-processing units.

The Consolidated Systems Division is ready to add to these basic units whatever output devices are needed to accomplish the test mission. These range from CEC's own MilliSADIC, ground playback and demodulator units, and recording oscillographs to the equipment of other manufacturers, such as oscilloscopes, spectrum analyzers, and chart recorders.



For the Total Answer to your data-processing problems... whether in connection with today's or tomorrow's aircraft and missiles... it will pay you to call in the experienced engineers of Consolidated Electrodynamics. There's no obligation. And for the story of DataTape, send today for Bulletin 1561-X16.

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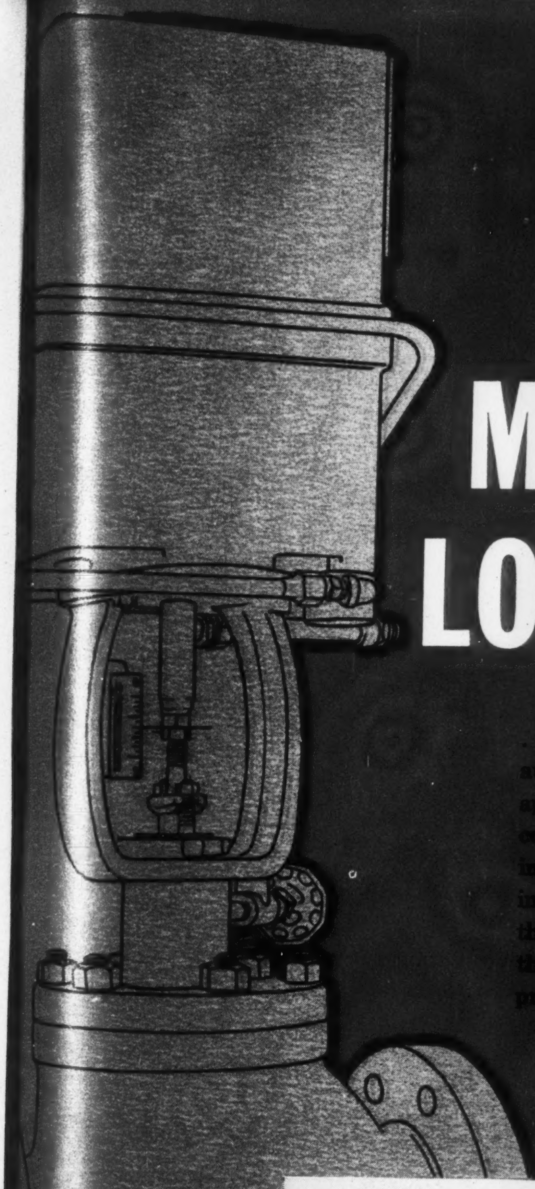
300 North Sierra Madre Villa, Pasadena, California

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

Sales and Service Offices in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.

For more information circle **56** on inquiry card.

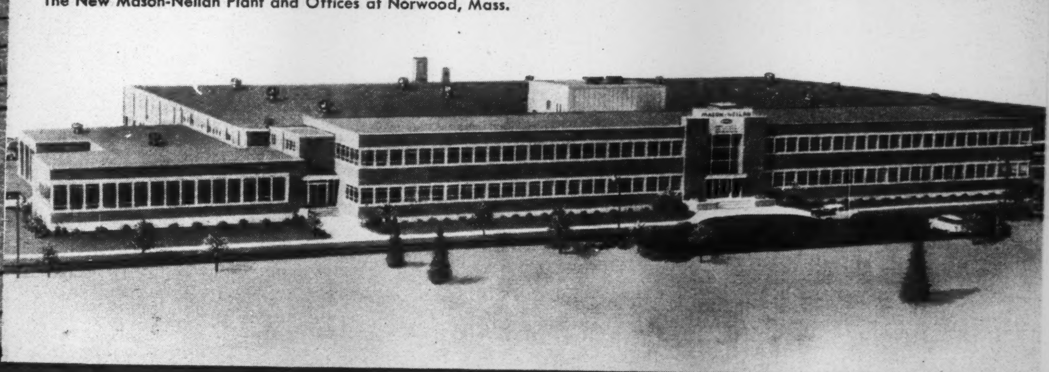


From a New Vantage Point

MASON-NEILAN LOOKS FORWARD

. . . to continuing and increasing its contributions to the automatic control field. Seventy-four years of experience, applied with enlarged and improved facilities, promises a continuance of high quality standards and improvements in the four basic groups of Masoneilan products, *plus* an increased tempo in the development of new products for the rapidly widening scope of automatic control. One of these is already here . . . a brand new valve actuator, presented on the following pages.

The New Mason-Neilan Plant and Offices at Norwood, Mass.



NOW . . . for a Forward look in MASONEILAN Control Valves, turn

SEE THESE NEW
DEVELOPMENTS
AT BOOTH 224

I.S.A. EXHIBIT
SEPT. 17-22

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NEW.
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MASONEILAN
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Electrohydraulic Valve Actuator with Premium Dynamic Performance

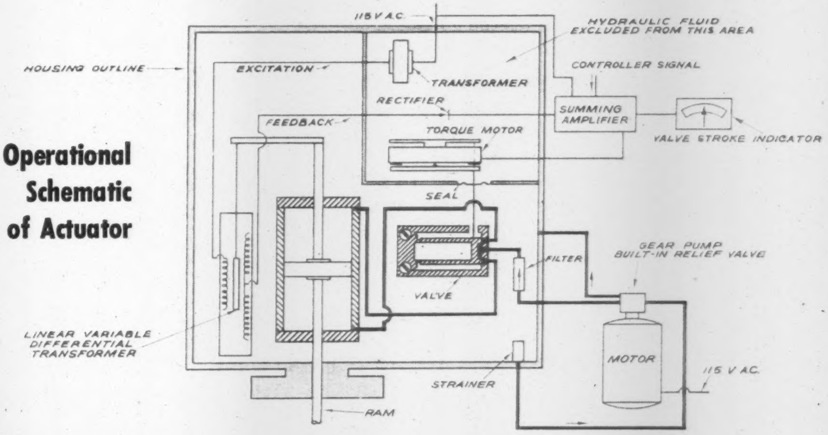
This first unit in an extensive program for the development of a complete line of electric actuators for Control Valves, incorporates the superior dynamic performance made possible by the electrohydraulic principle. It is designed primarily for the larger valves — 6″ to 16″ — requiring an extra margin of available power for reliable, positive performance and for installations where, as in remotely controlled pipeline stations, elimination of compressed air equipment makes these actuators economically feasible.

Some advantages of this actuator include —

- Maximum service life and minimum error in reproducible positioning through use of a linear differential transformer for electrical feedback
- Speed equal to, or greater than, pneumatic operation.
- Excellent linearity of plug position to signal.
- Operation with any presently available electronic control system.
- Operation under all normal ambient temperature variations.
- Availability of remote indication of valve plug position.
- Availability of explosion-proof construction. (Class 1, Group D, or other classes and groups as desired.)

Complete specifications on request

Operational Schematic of Actuator


115 V AC.
HYDRAULIC FLUID EXCLUDED FROM THIS AREA
HOUSING OUTLINE
EXCITATION
TRANSFORMER
CONTROLLER SIGNAL
RECTIFIER
SUMMING AMPLIFIER
FEEDBACK
TORQUE MOTOR
VALVE STROKE INDICATOR
SEAL
GEAR PUMP BUILT-IN RELIEF VALVE
FILTER
VALVE
LINEAR VARIABLE DIFFERENTIAL TRANSFORMER
MOTOR
115 V AC.
STRAINER
RAM

MASON-NEILAN
Division of Worthington Corporation
55 NAHATAN STREET, NORWOOD, MASSACHUSETTS

MASONEILAN

For other Mason-Neilan developments see next page

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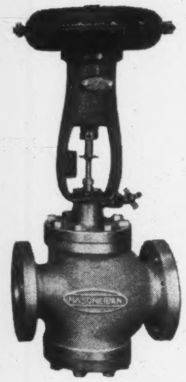
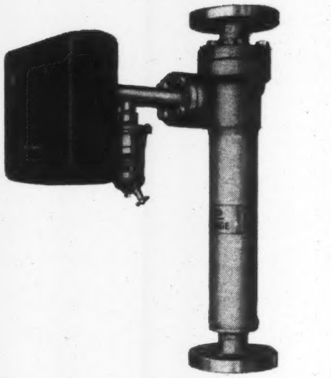
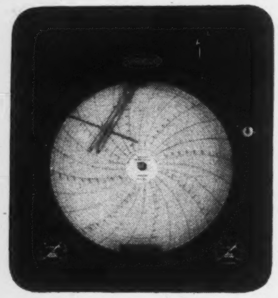
ALL HIGH CQ PRODUCTS



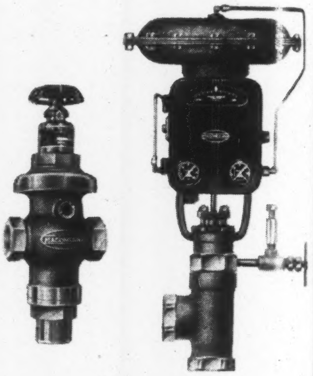
Complete Line of Air-operated Control Valves



The Versatile 12000 Series Liquid Level Controllers and Transmitters



Non-Indicating, Indicating and Recording Pneumatic Controllers and Transmitters



Pressure Regulating Valves for Reducing, Back Pressure, or Pump Pressure Service

PLUS
These Other
New Developments

SEE THEM AT BOOTH 224
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Pneumatic Selector Switch for Automatic Filling or Draining of a Series of Tanks

A New Liquid Level Controller Especially Adaptable to Separator Service

A New Two-Position Signal Switch

A New Side Mounted, Continuously Connected, Handwheel for Large Valves, Incorporating Up-and/or Down-Travel Stops which are Adjustable While Valve is Throttling

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INSTRUMENTS and AUTOMATION

Biographies of significance

SIGNIFICANCE

This month we add the basic instrumentation field of power generation to the fields of refinery processing, research, aviation, oil and gas distribution, plant construction, and simulation—each of which fields you have examined in terms of its outstanding men.

Henry Bennett has spent 36 years in the field of steam-station and power-generation instrumentation. He has participated in the construction of 4 steam stations and 20 steam-electric generation units, in sizes from 6000 kw (in 1924) to 156,000 kw (in 1955-56). He has been an active member in the Southern California Meter Association, the Pacific Coast Electrical Association, and the California Natural Gasoline Association. He is now Field Engineer, Steam, with the Southern California Edison Company. You will find some views of his Redondo station on pages 1532 and 1533 of this issue.

We are pleased to acknowledge the important contributions made to the field of power-plant instrumentation by Henry Bennett, and his important position within the field.

HENRY CHARLES BENNETT

Henry Charles Bennett was born in Kirkwood, Missouri, on March 3, 1903. He completed elementary school in 1918, attending Adult Night Hi School for chemistry, physics, mechanical drawing, mathematics and typing. He then enrolled in correspondence courses in combustion and steam-plant operation, and completed a course in Steam Turbines by Westinghouse Mfg. Co. He helped organize the annual Instrument Short Course (Los Angeles Harbor) in 1951.

His first job was an apprentice as a machinist in a war-time ship building company, in 1918. In August, 1919, he joined the Southern California Edison Company, rising through the positions of Watertender, Junior Fireman, Asst. Instrumentman, Boiler Room Engineer, Combustion Engineer, Test Engineer, and Efficiency Engineer, to Foreman Instruments Steam Division Maintenance, and Field Engineer, Steam, his present position.

He married Lauretta Emily Cole in 1924, and has 5 children (four boys and a girl).

In 1919, the Long Beach Steam Station was considered one of the most efficient steam-electric stations in the country, with 3 vertical turbine generators and 24 boilers. Instruments such as inclined draft gages, indicating flow meters, pressure gages and water columns, were then the ultimate of modernization for the boiler control. Flue-gas instruments, such as recording gas temperature and CO_2 analysis were just being installed. Draft was controlled by hand dampers. On the turbine, instruments consisted of indicating and recording thermometers, pressure gages, reed-type tachometers and valve position indicators. A wall-type synchroscope, common to all units and with a chain and sprocket device for turning the synchroscope in the direction of unit coming up, was also used. The generator output was measured with integrating wattmeters, with various indicating voltmeters and ammeters for auxiliary circuits.

In contrast, today's instrumentation at the 4 plants of the Southern California Edison Company throughout Central and Southern California features centralized control of turbogenerators, power dispatching, combustion, etc. All construction of 1951 and later has been of the centralized control type (see pages 1532 and 1533).

"Benny" tells us that the most recent and modern instrumentation trends in the steam power generation field are:

- Oxygen anlyzers for feed water systems
- Viscometers
- Sonic tests of equipment
- Visual inspection by borescopes
- Magnaflux and Zyglow tests
- Hydrogen and nitrogen leak detectors
- TV monitoring

The number of men in Steam Generation Maintenance Instrument activities at present in his company is 25 (this does not include Electrical Test Men, etc.).

Benny also tells us "I have been reading *Instruments* magazine since the initial publication (pocket size editions) 28 years ago. My personal subscription began in the early 1930s.

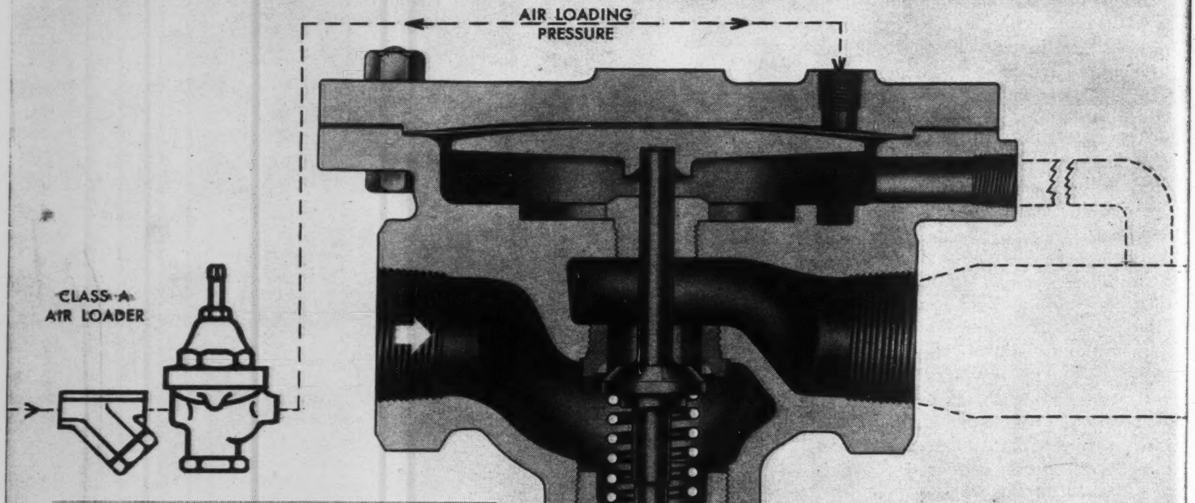
"*I* & *A* has been a very valuable tool to me and my associates in following the trend of instrumentation in the past 30 years, for the improvement of maintenance, operating problems, instrument and control applications, and supplying easy-to-get information from the manufacturers by using your index and numbering system."

In the past four years Benny's job functions have been directed to steam power plant problems, employee training, and assembling data and material for maintenance of his steam-electric generating stations.

Benny is a member of Signal Lodge #543 F. & A. M. (member 27 years); member and Past President of the Southern California Meter Association (member 20 years); and has participated in committee work on instruments, fuels, and combustion control as a member of the Pacific Coast Electrical Association (member 30 years), and member of the California Natural Gasoline Association (member 5 years).

His spare time is occupied with Boy and Girl Scout committeeman activities, and making odds and ends from wood and metal for home, P.T.A., and others.

No maintenance inspection on this new valve until 1959!



It's Maintenance-Free
LESLIE
EXTERNAL VIEW, CLASS GPK

You can just put this amazingly simple and compact Leslie Class GPK-A pressure reducing valve on the line and forget it for at least 3 years!

YES, AND THAT'S A *GUARANTEE* backed by a reputation for quality established in more than half a century of design, development and manufacture of regulators and controllers.

This amazing new, diaphragm operated, Leslie pressure reducing valve has *only two moving parts:* no seals; no stuffing boxes; no small, dirt-catching parts.

A simple air loader eliminates the conventional bulky loading spring and provides accurate diaphragm loading that gives pilot-type response. Yet, it is rugged and uncomplicated. The unit itself lends itself readily where remote adjustment is an advantage, too. And you pay no price premium for these advantages. You get Leslie quality for about the same initial cost as leading makes of ordinary regulators.

Suitable for any steam service up to 250 psi, 450°F, the unit is available in ½" to 2" sizes. It is ideal for intermittent service too, and is unaffected by dirty steam.

Your Leslie engineer can give you all the data on this amazing valve. You'll find him listed in your classified directory under "Valves" or "Regulators".

Send for YOUR copy of Bulletin 561 today.

TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

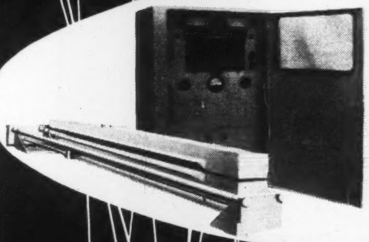
LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

For more information circle **58** on inquiry card.

NEW CONCEPTS . . .

IN PROCESS CONTROL INSTRUMENTATION

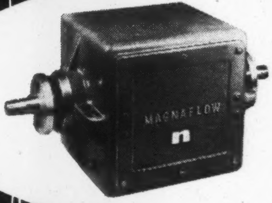
PERFORMANCE-PROVEN DESIGNS
INCREASE PRODUCTION OUTPUT
INSURE ACCURATE CONTROL



Precise THICKNESS Control

WITH NUCOR ATOMAT NON-CONTACT BETA GAUGES

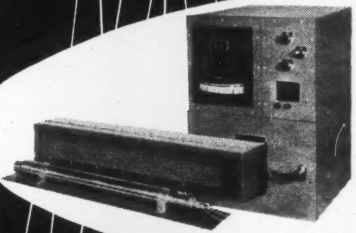
The ATOMAT high-precision series of NON-CONTACT BETA gauges offers instantaneous, **continuous** gauging for a wide variety of sheet materials and coatings . . . regulates product weight or thickness to better than 1% . . . dependable operation on sheet speeds up to 3,500 ft/min . . . webs up to 20 feet . . . greater accuracy than **any** other method . . . write for Brochure 1100A.



Precise FLOW Control

WITH NUCOR MAGNAFLOW ELECTROMAGNETIC FLOW METERS

MAGNAFLOW straight-thru flow meters have zero pressure drop . . . no obstructions are present in the smooth-bore teflon tube . . . no moving parts . . . continuous accuracy of better than 0.1% can be achieved for most applications . . . calibration is independent of viscosity, density, temperature . . . can accept extremely high liquid resistivities . . . perfect measuring equipment for sanitary and other difficult problems. Full information is in Brochure 1200A — Write for a copy.



Precise LEVEL Control

WITH NUCOR NUCLEAR LEVEL GAUGES

Now . . . level indication where conventional methods fail . . . readings are completely unaffected by temperature, by pressure . . . installation external to tanks or cupolas . . . remote indication and fully automatic control for a wide variety of liquids and materials . . . rugged construction . . . stable performance. Full information is in Brochure 1300A — Write for a copy.

ADVANCED-DESIGNS FROM A GREAT NAME IN PROCESS CONTROL EQUIPMENT

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SEE NUCOR EQUIPMENT IN ACTION AT BOOTH 1209 ISA SHOW

For more information circle **59** on inquiry card.

Operators in the foreground are trimming resistors down to close approximation of their final values, guided by L&N No. 4760 Bridges.

88 L&N Bridges work

ROUND THE CLOCK

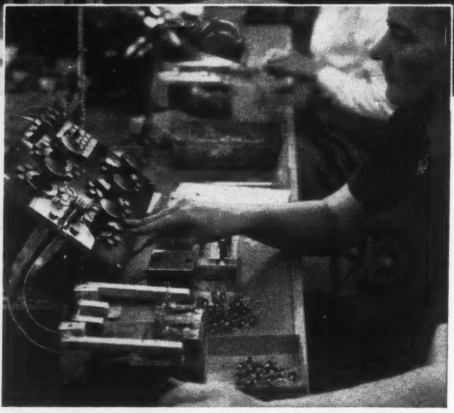
on resistor calibration

Continuous operation on production work is an exacting job for any precision instrument. But Resistance Products Company, Harrisburg, Pa., depends on L&N Bridges to measure precise resistors on a two and three shift basis. Some bridges have been in operation as long as nine years without any attention except routine maintenance.

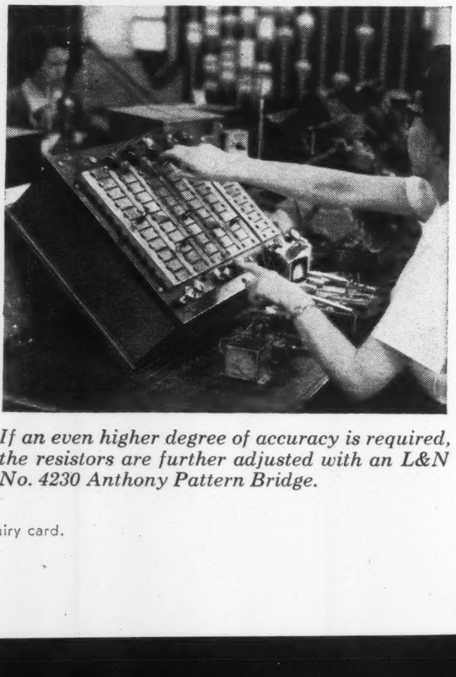
Low maintenance and high precision are especially valuable, since many RPC resistors must be adjusted to a high accuracy, for use in guided missiles, computer networks, printed circuits, etc.

If we can help you select instruments for similar applications, from L&N's line of rugged, precise bridges, galvanometers and potentiometers, just let us know. A Field Engineer will either call or send printed information as you wish. Please write us at 4955 Stenton Avenue, Philadelphia 44, Pa., for Data Sheet Group E-53 describing L&N Bridges.

LEEDS LN NORTHRUP
instruments *automatic controls • furnaces*



After the resistors are annealed to stabilize their resistance values, they are more precisely adjusted with an L&N No. 4725 Bridge.



If an even higher degree of accuracy is required, the resistors are further adjusted with an L&N No. 4230 Anthony Pattern Bridge.

For more information circle **60** on inquiry card.

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—***M. H. Aronson,*** Editor

The General-Purpose

ELECTRONICS TEST INSTRUMENT INDUSTRY

THE INDUSTRY was defined as "Producers of General-Purpose Instruments for Test and Measurement of Electronic Properties." Careful attention was given to differentiating between "Electronics Test Instruments" and "Electrical Quantity and Characteristic Test and Measurement Instruments." Categories and definitions were also established for closely related, but dissimilar, items such as Sound Measuring Instruments, Laboratory Power Supplies, etc.

The 262 firms producing Electronics Test Instruments were identified by a careful check of the War Production Board, the National Production Authority and the Business and Defense Services Administration allocation records, supplemented by a similar check of the related trade journals and buyers' directories, plus a review of military procurements for this type of equipment during the past five years.

Over-all Statistics

Tables show the numbers of companies in the field, the dollars of production and percentages of annual production volume, arranged by employment size groups and by types of firms. Certain conclusions can be drawn from these tables:

1. Almost sixty percent of all electronics test instruments are produced by firms which specialize in this field of activity.
2. Production of electronics test instruments is very widely dispersed among a large number of firms, which are predominantly in the "small business" category. The largest producer has less than 1,000 employees and receives less than 10% of the total orders for equipment of this type.
3. 51 companies (20%) employ 9,000 workers (75%) and produce $115,000,000 annually (75%). These firms each employ 50 or more workers in electronics test instrument production. Detailed industry analysis

TABLE I Distribution of Numbers of Producers of Electronics Test Instruments by Employment Size Groups
(000,000 added)

	Group A[1]	Group B[2]	Group C[3]	Totals	
Over 500 Employees*	3			3	(1%)
150 to 500 Employees*	8	3		11	(4%)
50 to 150 Employees*	16	12	9	37	(14%)
15 to 50 Employees*	26	43	20	89	(34%)
Under 15 Employees*	28	43	51	122	(47%)
Totals	81	101	80	262	(100%)

TABLE II Distribution of Annual Dollar Volume of Electronics Test Instrument Producers by Employment Size Groups
(000,000 added)

	Group A[1]	Group B[2]	Group C[3]	Totals	
Over 500 Employees*	$31 (20%)			$31	(20%)
150 to 500 Employees*	$30 (19%)	$11 (7%)		$41	(26%)
50 to 150 Employees*	$17 (11%)	$12 (7%)	$14 (9%)	$43	(27%)
15 to 50 Employees*	$ 9 (6%)	$14 (9%)	$ 7 (4%)	$30	(19%)
Under 15 Employees*	$ 3 (2%)	$ 4 (3%)	$ 5 (3%)	$12	(8%)
Totals	$90 (58%)	$41 (26%)	$26 (16%)	$157	(100%)

---

* Engaged in Electronics Test Instrument Production

[1] Group A. General-purpose Electronics Test Instrument production comprises more than half of the firm's total activity.

[2] Group B. General-purpose Electronics Test Instrument production comprises less than half of the firm's total activity; however, other products are closely related in terms of manufacturing facilities and production experience.

[3] Group C. General-purpose Electronics Test Instrument production comprises less than half of the firm's total activity; other products are of a different nature in terms of manufacturing facilities and production experience.

An Industrial Mobilization and Defense Planning Study by the Scientific, Motion Picture and Photographic Products Division, of the Business and Defense Services Administration, U.S. Department of Commerce.

can be applied to these 51 firms to obtain a relatively complete picture of the industry as a whole.

Other interesting statistics, obtained as a by-product of the preparation of the tables: electronics test instrument producers use an average of 180 square feet per employee; they produce $12,000 per employee annually, on the average.

There is no concentration of military instrument production among a few producers. The data used to prepare Table VII revealed that 99 firms had received contract awards during the period studied. The firm receiving the largest total dollar value of contracts over this period produced less than $10,000,000 worth of equipment, or an average of less than $2,000,000 per year.

The Meaning of "Electronic Properties."

The definition for electronics test instruments, "general-purpose instruments for the test and measurement of electronic properties," hinges upon the phrase "electronic properties." Frequency (other than power supply), voltage (at frequencies other than power supply, or occurring in high impedance circuits), impedance (measured at other than power supply frequencies), power (at other than power-supply frequency), electromagnetic field, waveform (except at power frequencies), and the like are electronic properties. Such properties are understood clearly by those trained in the electronics field.

TABLE III Producers of Functional Types by Employment Size Groups

	Over 500 Emp.*	150 to 500 Emp.*	50 to 150 Emp.*	15 to 50 Emp.*	Total**
Voltage and Current Measuring Instruments	2	2	15	17	36
Frequency and Time Interval Measuring Instruments	3	7	11	25	46
Impedance and Standing Wave Ratio Measuring Instruments	3	4	10	22	39
Power and Electromagnetic Field Measuring Instruments	2	5	13	11	31
Waveform Measuring and/or Analyzing Instruments	3	6	19	17	45
Signal Generating Instruments	3	10	19	43	75
Active*** Network Type Instruments, for Test and Measurement Purposes	3	4	14	17	38
Passive**** Network Type Instruments, for Test and Measurement Purposes	2	4	17	21	44

* Engaged in Electronics Test Instrument production

** Of firms having more than 15 employees engaged in Electronics Test Instrument production.

*** Active means with operating vacuum tubes.

**** Passive means with only passive elements.

TABLE VI Military-Type Instrument Production by Years

(000,000 added)

	1951	1952	1953	1954	1955	Early 1956	Totals
100. Voltage & Current Measuring Inst.	$ .3	$ 1.0	$ 2.5	$ .1	$ .3	$ .1	$ 4.3
200. Frequency & Time Interval Meas. Inst.	10.8	8.0	1.0	8.3	1.4	1.7	31.2
300. Impedance & Standing Wave Ratio Meas. Inst.	.2	.1	.1	.6	.4	.1	1.5
400. Power & Electromagnetic Field Meas. Inst.	2.3	4.9	1.1	.4	1.7	.2	10.6
500. Waveform Meas. and/or Analyzing Inst.	7.2	4.3	1.8	.1	1.3	.3	15.0
600. Signal Generating Instruments	14.7	14.8	4.2	4.4	4.8	.9	43.8
700. Active Network Type Instruments	.1	1.5	1.3	.9	.1	—	3.9
800. Passive Network Type Instruments	.2	.1	.3	.4	.1	—	1.1
TOTALS	$35.8	$34.7	$12.3	$15.2	$10.1	$ 3.3	$111.4

Average Rate: $21,000,000 per year
Average Rate—Last Three Years: $12,500,000 per year

Dear D. R.*:

It's vacation time, and you could well devote one of your relaxin' days to the important things in this issue. We'll point them out here for you; some shouldn't be missed for *any* reason.

The first is "Information Theory," a hot new subject. A lot of high-powered equations have been written in this field and you may have been led to believe that the subject is for mathematicians. Well, it isn't. Martin Klein and his Rocketdyne co-authors show how simple and practical real information theory is. You'll love this one—guaranteed. It begins on page 1519.

Another field that is much in the news is dynamic response of systems (mathematicians have been having a field day applying the many analytical techniques to the many possible system characteristics). This subject gets complicated fast—but the abstracts of nine important papers which were presented at the ASME-IRD Conference at Princeton in March give a nice perspective of the state of the art of dynamic response. You will find these abstracts on pages 1543-45.

Bringing the same subject closer to the process field is the article "Dynamics of Liquid Flow Control" by Catheron and Hainsworth of Foxboro, who bring out the relative importance of the various time constants in the liquid flow process (on pages 1525-27).

Still another hot subject is automatic data processing. On pages 1536-39 you will see how Teleregister Magnetronic systems are being put to work in stock exchanges, reservation systems, warehouses, and banks.

Judging from our mail, the articles on Control Valves by Chet Beard are being read very, very finely. Chet continues this month (pages 1528-31) with combination valve actuators—electropneumatic, electrohydraulic, and pneumohydraulic.

Closely allied and nicely integrated with this article is "Electrohydraulic Position Control" by L. H. Geyer, on pages 1540-42.

There is a lot of news about shows this month. On eight full pages (1552-1559) you will find a pic preview of the giant ISA Show coming in September. And on pages 1514-1515 you will see that Mayor Wagner of New York has proclaimed the week of Nov. 26-30, the week of the Automation Exposition in New York, as "Automation Week."

The Simulation Council Newsletter report on the meeting on "Combined Analog and Digital Computation" is also exceptionally important. It shows that the analog vs digital argument is alive even when the subject is analog *plus* digital. That Convair facility described on page 1567 should make the entire process industry sit up—or should I say wake up?

Hope this finds you well and happy.

Milt and the Editors

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Automate -- or Die

MAYOR WAGNER of New York City has officially proclaimed the week of Nov. 26th to 30th, 1956 (the week of the Automation Exposition) as Automation Week in New York City, in a spirited declaration whose opening words are:

> **"Whereas: Our American goal of ever high quality products at costs which permit ever wider use has caused our business and labor leaders to devote ever increasing attention to automation and**
>
> **Whereas: Automation has thus achieved recognition as the principal material means of attaining the more productive and enjoyable life all men seek . . . . .**
>
> **Now, therefore, I, Robert F. Wagner, Mayor of the City of New York, do hereby proclaim November 26th to 30th, 1956, as**
>
> AUTOMATION WEEK
>
> **in New York City, and urge my fellow citizens and the visitors who will then be in our midst to take heed so that maximum advantages will accrue to us all and that there will be greater security and comfort in the world of the future."**

This is a logical climax to a year in which interest in automation has risen to white heat, in which automation has been discussed from the corner congregational Church to the halls of Congress. AUTOMATION—boon or burden? AUTOMATION—promise or threat? AUTOMATION—prosperity or unemployment? These have been the subjects of countless conferences and articles and analyses. Why this intense interest in automation?

The reason is a simple one: in a free competitive society the entrepreneur *must* automate—when it becomes economic to do so—or die.

*Automation is the use of mechanical, hydraulic, pneumatic, electrical and electronic devices for making automatic decisions and efforts.** Automation is the elimination of repetitive, onerous, dangerous and trivial labor, mental or physical. Automation is the science and art of production at maximum efficiency and minimum cost. The American industrialist or executive who does not automate his operations, who does not produce at maximum efficiency, who does not eliminate trivial labor and use his work force at ever higher levels, is opening the way to the destruction of his enterprise. If he doesn't automate, his competitor will. Ever-increasing efficiency is the heartbeat of our competitive industrial economy; it is the reason why the productivity of our economy surpasses any that is known to man; and it is inherently characteristic of a free competitive economy.

Thus it is seen that the science and art of production at maximum efficiency has a truly irresistable appeal to the entrepreneur. Where automation is economic, he must automate.

Why the Opposition?

If this is true, why is there such high interest, heated discussion, and not too thinly veiled opposition to automation? From whence springs the fear of automation?

One reason is that change of any type frightens many who see only that the present is good and the future unknown. However, it is a fact of life that our technological civilization is changing at an ever-increasing rate; that production processes change as inevitably as our bodies age; that we all must learn to accomodate to inevitable change.

A second reason for the fear of automation is lack of knowledge about the working of our economic system. For example, automation is examined too often in superficial manner—in terms of the labor displaced by the machine rather than in terms of the added productivity and increased economic activity that inevitably result from use of automation. Partisan groups make good use of the demagogic value of labor displacement: Organized labor to obtain a guaranteed annual wage; politicians to obtain headlines; editors to obtain readers—they all know that many people have been frightened by the word automation, and that people will listen to and read about something that frightens them.

Effect of Automation in Practice

To examine the effect of automation at work we should look at each of the basic fields in which automation is now extensive. These fields are (1) the *process industries* which use valves, controllers, and pickups to control the flow of water, gas, chemicals, petroleum products, steam, foods, and all flowing matter at every stage of their production, distribution and storage; (2) the *piece part industries* that use machine tools, motors, and assembly lines for the fabrication of automobiles, engines, refrigerators, furniture, and all materials that are handled in units; (3) the *business field* in which the problems are payrolls, inventories, production control, market analysis, scheduling, accounting, etc.; (4) the *field of research, development, and scientific calculations* which involve many measurements, high-precision labor, experimentation, etc. Although every industry and every field has some use (and exciting possibilities for more extensive use) of automation. The fields mentioned are today cohesive fields with common problems, common terminology, and common automation devices.

Few generalities—and even fewer specific facts—apply to all of these fields at one time. They should be examined individually. Such detailed examination shows that the primary result of using an automation device for a task previously performed manually—in any of these fields—is that the task is done more rapidly and more efficiently. This must be so because this is the only time an auto mation device is ever used—for the elementary reason that it is only under these conditions that the automation device becomes economic. Hence the result is always a larger operation, a greater output, an expanding industry.

---

*Definition first proposed by M. Aronson in 1954.

A steel mill that automates its blast furnaces must expand its open hearths, soaking pits, and rolling mills. An engine manufacturing plant that automates its assembly line must expand its stocks of all parts and its facilities for handling the increased output. The insurance company that uses computers to automate its calculating functions can perform analyses never before possible, opening the way to new policies, increased business, and more salesmen. Wherever the automation device is applied, the end result is a bigger operation with greater output. This means, in turn, more salesmen, more production space, more research, more warehouses, more promotion, more advertising, more diversification, etc.—exactly the pattern of our present prosperous and expanding society.

But this does *not* mean that automation either causes or threatens this prosperity and expansion. In the final analysis, prosperity depends only on the purchasing power of the country as a whole. If it is satisfactory, automation merely means more goods at cheaper prices; if purchasing power is unsatisfactory, there will be unemployment and economic difficulties, with or without automation.

Thus we see that there are no direct economic implications of automation. Automation is merely one of many industrial techniques that make possible the marvelous productivity of modern society.

The Future

Automation in every field of endeavor will lead more and more to (1) the elimination of repetitive tasks, (2) the upgrading of the work force at every level, (3) an economy based on continuous expansion, (4) ever increasing use of automation devices.

These trends have important implications for every business man, engineer and teacher. The teacher must no longer prepare men for any repetitive tasks; it is already more important to teach students how to keep abreast of future changes than to teach him past fundamentals and applications. The engineer must learn that his formal education only begins with his degree. The business man must also learn to adapt his organization to accelerating change.

These are not mere platitudes. Failure to accommodate to change has become too common at all levels of our society. How many engineers read even one or two technical text books each year? How many teachers teach their students the importance of reading not only these books but the magazines in their field? How many industrialists provide a climate which forces their staff to study and grow in ability?

Our jobs no less than our lives will change as the years go by. Such change is inevitable, and it is every man's personal responsibility to devote a portion of his time to advancement within his field.

Such basic education could well begin by signing up for a course in automation equipments; more than 100 clinic classes will be held in conjunction with the forthcoming Automation Exposition in New York, Nov. 26-30, 1956.

A Process Lag?

FOR several years we have emphasized repeatedly the importance of process control analysis via simulation and analog computation; we have investigated the many ways in which these techniques can open new vistas of instrumentation; how they could change the entire character of operating instrumentation and advance the engineering and instrumentation department into new areas of great promise. Thus the lead of the aircraft industry (vividly demonstrated by the description of the Convair analog-computing laboratory on page 1567) over the processing industry in the techniques of analog simulation should be of concern to the entire processing industry.

In the interest of objectivity and perspective it must be pointed out that the lead of the aircraft industry in this matter of simulation is not due to the superior intellects or training of the men in that industry; governmental development money has been behind many of the developments in the aircraft industry. Although several chemical and processing plants are applying analog simulation to their design problems, the field of even greater application – analysis of the operating process plant—has hardly been scratched; and one reason for this is the backwardness of "instrument men" in the process industries.

This message is aimed primarily at you who are in charge of the instrumentation of process plants. The efficiency and degree of control of the plant is your responsibility—and too often you have been content with calibrating your flowmeters and repairing your pressure gages. A further evasion of your responsibility—and a more serious one—has been your neglect of your college math and your failure to learn operational math. This developing weakness in background has led you to consider computers as the exclusive domain of mathematical geniuses, and the operating efficiency of your own plants has suffered as a result.

What can you do about this? It is never too late to do what should have been done long ago. *Learn* the techniques of simulation and analog computation, and *apply* them to your own plants. A little study will revive your dormant math background. Sign up for every one of the analog-computer clinic classes at the Third International Automation Exposition, New York, Nov. 27-30, where you will learn that analog computers are rather simple devices for analyzing your own plant and telling you what limits your present operating efficiencies, and exactly where you can increase the efficiency—either by change in control system or by change in process equipment. Then get your plant management to install one analog computer—perhaps the smallest one you can find—in your instrument department. Once you have the equipment you will start analyzing your unit operations and thus gain insight into the mechanism of your industry. The responsibility is yours! *MHA.*

AUTOMATION WEEK
in New York City

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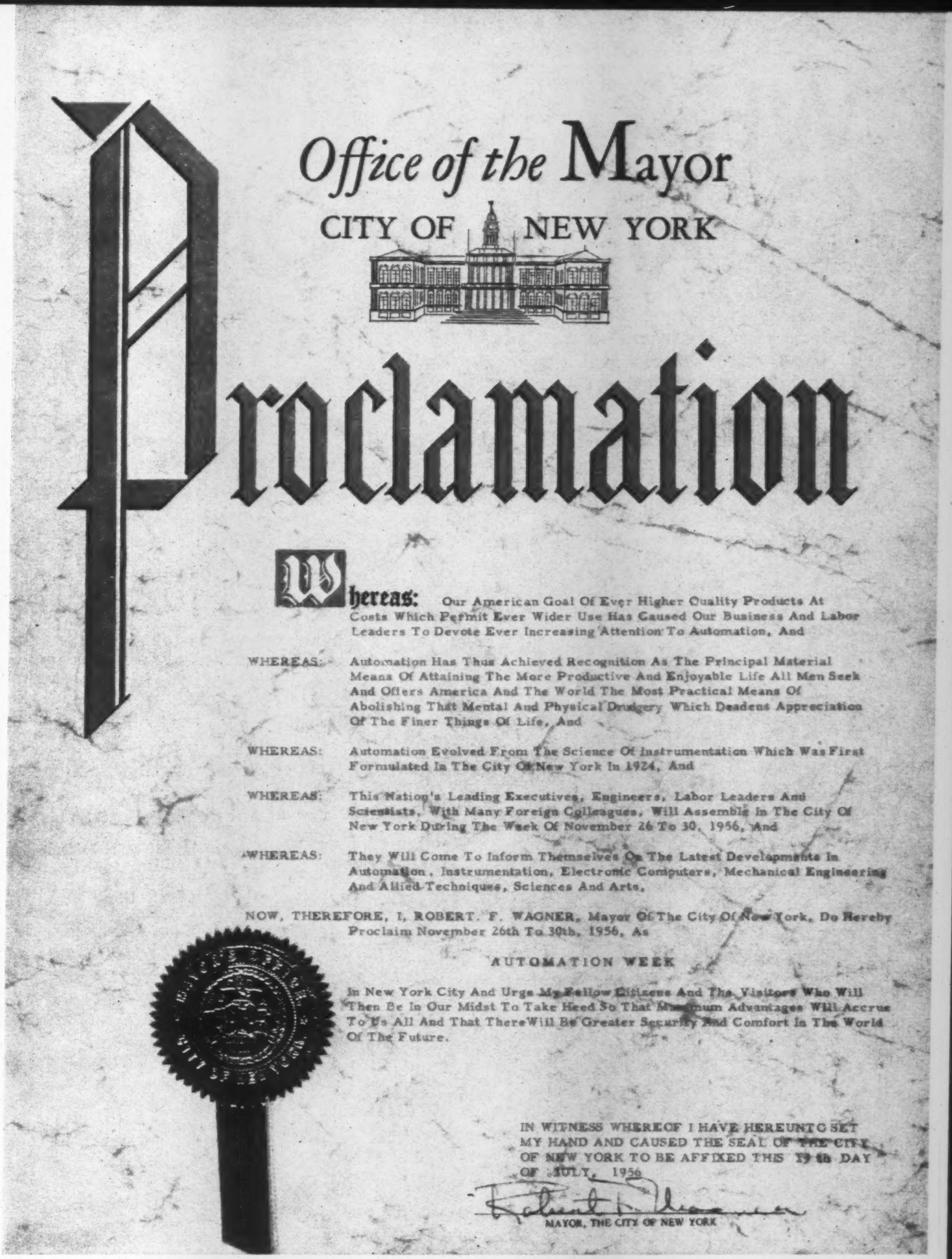

Office of the Mayor

CITY OF NEW YORK

Proclamation

Whereas: Our American Goal Of Ever Higher Quality Products At Costs Which Permit Ever Wider Use Has Caused Our Business And Labor Leaders To Devote Ever Increasing Attention To Automation, And

WHEREAS: Automation Has Thus Achieved Recognition As The Principal Material Means Of Attaining The More Productive And Enjoyable Life All Men Seek And Offers America And The World The Most Practical Means Of Abolishing That Mental And Physical Drudgery Which Deadens Appreciation Of The Finer Things Of Life, And

WHEREAS: Automation Evolved From The Science Of Instrumentation Which Was First Formulated In The City Of New York In 1924, And

WHEREAS: This Nation's Leading Executives, Engineers, Labor Leaders And Scientists, With Many Foreign Colleagues, Will Assemble In The City Of New York During The Week Of November 26 To 30, 1956, And

WHEREAS: They Will Come To Inform Themselves On The Latest Developments In Automation, Instrumentation, Electronic Computers, Mechanical Engineering And Allied Techniques, Sciences And Arts,

NOW, THEREFORE, I, ROBERT. F. WAGNER, Mayor Of The City Of New York, Do Hereby Proclaim November 26th To 30th, 1956, As

AUTOMATION WEEK

In New York City And Urge My Fellow Citizens And The Visitors Who Will Then Be In Our Midst To Take Heed So That Maximum Advantages Will Accrue To Us All And That There Will Be Greater Security And Comfort In The World Of The Future.

IN WITNESS WHEREOF I HAVE HEREUNTO SET
MY HAND AND CAUSED THE SEAL OF THE CITY
OF NEW YORK TO BE AFFIXED THIS 19th DAY
OF JULY, 1956

MAYOR, THE CITY OF NEW YORK

See pages 1467-1468 and 1516-1517 in this issue of INSTRUMENTS & AUTOMATION for more facts about the Exposition and Clinics.

For Executive Conferences details, write to Richard Rimbach Associates, Management, Third International Automation Exposition, 845 Ridge Avenue, Pittsburgh 12, Pa.

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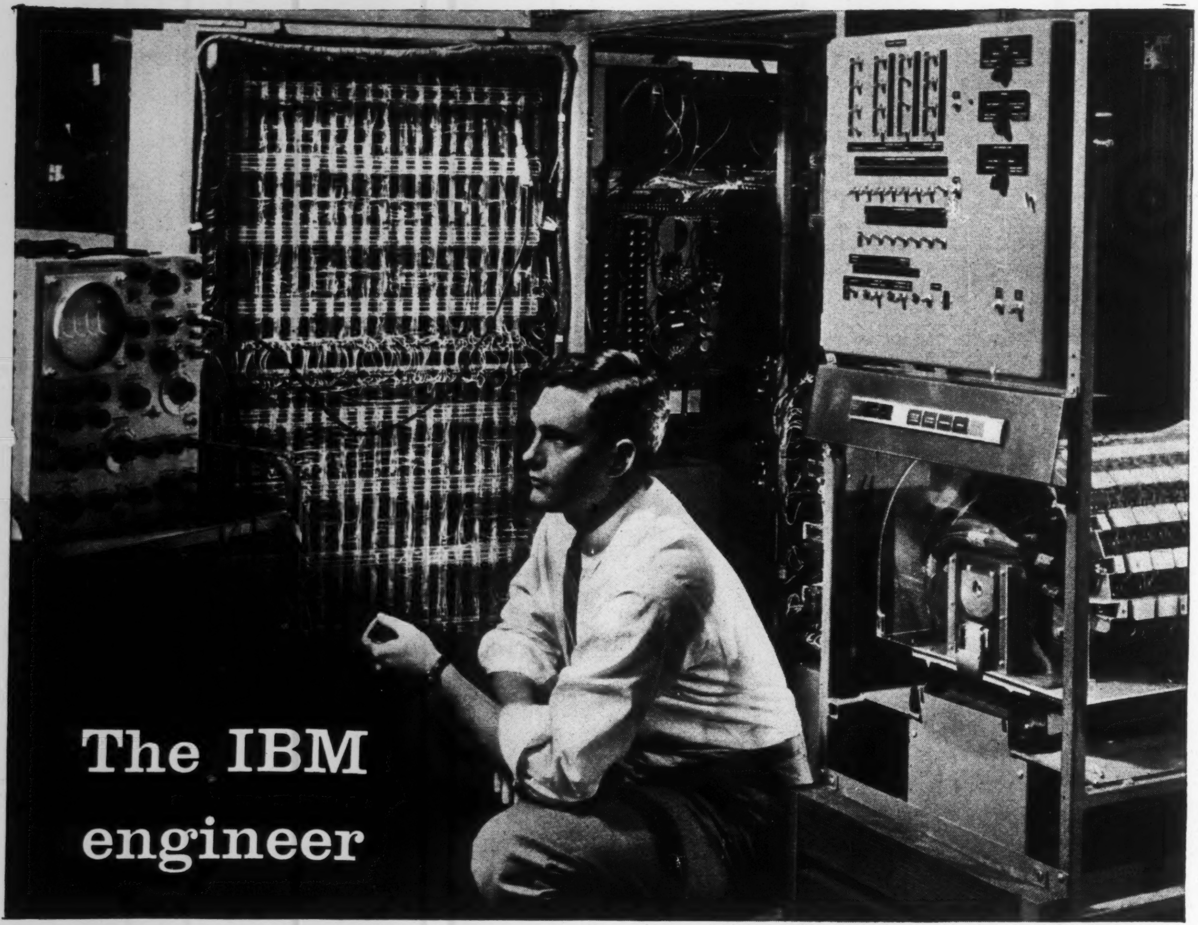

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Digital Automation—No. 10

Information Theory

MARTIN L. KLEIN
FRANK K. WILLIAMS
HARRY C. MORGAN
Rocketdyne Div.,
North American Aviation, Inc.

Information theory provides a means for comparing analog and digital systems, and for designing digital systems to have an accuracy equivalent to a given analog system. This is done by relating the time for the analog signal to change through its minimum detectable change (resolution of system) to an equivalent bit rate. The maximum required bit rate is shown to be simply the "information content" of one reading (in bits) divided by the time for the signal to change through this minimum detectable change.

INFORMATION THEORY was developed to satisfy a realistic problem. Fundamentally it is this: How many messages can be transmitted over a wire at the same time? Thus it is not surprising that the original work along these lines was done at the Bell Telephone Laboratories, where work was undertaken as early as 1927 by R. V. L. Hartley and more recently by Claude E. Shannon. An extension of the original question can be made: How much information can be transmitted over a wire in the presence of noise? (Here, noise is defined as any spurious and wanted signals which creep into the communication channel.)

In digital automation, where high-level signals can be transmitted and information obtained relatively free of noise, we can state the problem as follows: How many times must we sample a channel to insure that we are not losing any significant information?

It has already been pointed out that multiplexing and analog-to-digital converting require finite intervals of time during which we cannot examine what is happening to the information. Hence there must be a *quantitative* measure of exactly how to go about insuring that nothing of significance is lost. In fact, these criteria establish whether or not the digital system for automation is operating satisfactorily.

Quantization of Variables

Fig. 10-1 shows an arbitrary plotting of a variable (perhaps a pressure, temperature, or displacement) as a function of time. The dependent variable, y, has a maximum value y_{max} and a minimum value y_{min} as shown. The *range* of value of y is then given by

$$y_m = y_{max} - y_{min} \tag{1}$$

It is obvious that y can assume any of an infinite number of values within this range. Nevertheless, irrespective of the instrument used to make this measurement, there is a definite minimal incremental value that can be sensed, which is a function of the resolution of the instrument. This minimal incremental value we shall call Δy. Therefore, when the measurement is made, there are really only a finite number of discrete values that can be obtained, and this number can be expressed as

$$n = \frac{y_m}{\Delta y} + 1 \tag{2}$$

For example, if the reading is between 0 and 1 volt, and the minimal measurable increment is 0.1 volt, then the maximum number of discrete readings must be

$$\frac{1}{0.1} + 1 = 11$$

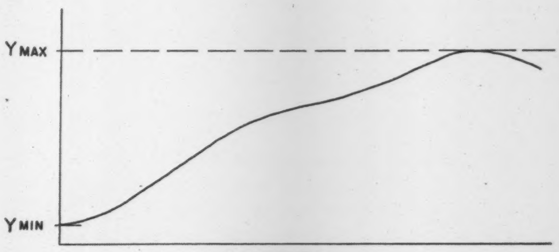

Fig. 10-1. Analog signal with minimum value Y_{min} and maximum value y_{max}. If system resolution is Δy, the variable can have only n possible values between y_{min} and y_{max}, where n equals $\frac{y_{max} - y_{min}}{\Delta y} + 1$.

The general approach and some of the material used in this chapter is due to Sidney D. Millstone, North American Aviation, Inc., Los Angeles, Calif.

This says that there are only 11 such possible values between 0 and 1.0.

The minimal error (Δy) is known as the resolution of the system. It can be expressed as a function of the allowable error (ϵ) of a system (expressed in %) as follows:

$$\Delta y = \left(\frac{2\epsilon}{100} \right) (y_m) \tag{3}$$

This says that if we are to measure a pressure within a 100-psi range (y_m) to an allowable error of 1%, the resolution of the system is 2 psi.

Effect of Rate of Change of Variable

Let us consider a variable which is changing in value at a rate of 1% of the full-scale range per second. Let us assume that we can measure the variable, when it is static, to an accuracy of 1%. If we can examine the reading rapidly, in say 1/1000 of a second, we are reading at a speed that is high compared to the change in variable during the reading interval; the variable can change by only 1/1000 of 1% while the reading is being taken. On the other hand, if we require 10 seconds for a reading, the variable can change through 10% of its range while the reading is being taken. In the first case the reading was made with a *dynamic accuracy* exceeding the *static accuracy*. In the latter case, the dynamic accuracy was less than the static accuracy. However, if the rate of change of variable is less than 1%, the dynamic accuracy of the latter case improves. In other words, the faster the variable changes, the greater is the accuracy lost during the measurement interval. This, of course, is the result of the variable changing during the fixed reading interval.

The time interval for the variable to change an amount equal to the resolution of the system is given by

$$T_r = \Delta y / \dot{y} \tag{4a}$$

In other words, if the resolution is 2 psi, and the variable is changing at a rate ($\dot{y}$) of 1 psi per second, the time interval for the variable to change 2 psi is 2 seconds. (Here $\dot{y}$ means dy/dt.)

The smallest time interval for the variable to change an amount equal to the resolution of the system is simply the minimal increment divided by the *maximum* rate of change of the variable:

$$\Delta T = \Delta y / \dot{y}_{max} \tag{4b}$$

Let us assume that this rate of change persisted in traversing the range of the measurement. The minimal time to obtain a full-range change in variable is then

$$T = y_m / \dot{y}_{max} \tag{5}$$

$$\dot{y}_{max} = y_m / T \tag{6}$$

If we insert equation 6 and 3 into 4b, we obtain

$$\Delta T = 2 \left(\frac{\epsilon}{100} \right) y_m \left(\frac{T}{y_m} \right)$$

$$= \frac{2\epsilon T}{100} \tag{7}$$

Equations 3 and 7 are similar in form and we have defined the minimal time and variable increments for the system. Equation 7 tells us the minimum time for the variable to change an amount equal to the resolution of the system (the minimum detectable change) in terms of the measurement error and the approximate rise time of the system.

Information Content

Any message or measurement can be considered to consist of a certain number of basic elements. For example, if the message is in the English language, each letter must be one of 26 possible letters (or one of 27 possible units of information if a "space" is considered a part of the message). If the message or measurement is expressed in binary code, then each unit of the information can be one of only 2 possible occurrences—commonly expressed as 0 or 1. In the measurement referred to previously, the total number of possible values of the variable was given as

$$n = \frac{y_m}{\Delta y} + 1 \tag{2}$$

Without any knowledge of limiting or restricting conditions associated with the message or measurement, we must say that each element in the measurement is as likely to occur as any other. In other words, all values are of equal probability; the variable can be 1 volt as easily as 2 or 3 volts; to say otherwise is to exclude certain ranges of the variable and thus propose a less general situation.

The device handling the message or measurement must be capable of handling every possible alternative. If transmitting letters of the English alphabet, it must be capable of transmitting 26 different but equally probable letters; if transmitting one binary digit or bit, it must be capable of 2 different but equally probable states; if handling decimal numbers, it must be capable of 10 states; in the measurement problem, it must be capable of $(y/\Delta y) + 1$ states.

The total amount of information in any message or measurement can be expressed conveniently in terms of the *logarithm* of the number of different possible states. The logarithm is most convenient because it is the exponent of a base number and thus permits simple mathematical treatment. For example, adding one more binary character to others (or one more relay to others) doubles the total number of possibilities. This is an *exponential* increase and the fact is stated most simply in exponential (logarithmic) manner.

Hence *we can define the information content of a message or measurement as*

$$H = \log n$$

where n is the total number of possible conditions. Where all events are of equal probability, the probability of any one occurring is obviously 1/n. That is, one die has 6 possible faces; the probability for any one face turning up on one throw is 1/6. As the probability p equals 1/n, the information content can be expressed in any of the following ways:

$$H = \log n = \log (1/p) = -\log p \tag{8}$$

This gives us the information content of any given reading or signal or message.

If the base 2 is used, H is in binary digits, or bits.

If the base 10 is used, H is in decimal digits.

If the base e is used, H is in natural units.

For example, a single binary digit has a probability of ½. Hence the information content of a 1-bit reading is $-\log_2 \frac{1}{2}$, or 1 bit. Two binary digits have 4 possible states; hence the information content of a 2-bit reading is $-\log_2 \frac{1}{4}$, or 2 bits. Three binary digits have 8 possible states; hence the information content is $-\log_2(1/8)$, or 3 bits.

Changing the base of the logarithm simply represents changing the units in which the information content is expressed. To change from base a to base b it is necessary only to multiply by $\log_b a$. As $\log_2 10$ is 3.32, $\log_2 X = 3.32 \log_{10} X$. Note that one decimal digit contains 3.32 bits of information; and that a number expressed in binary notation requires 3.32 more digits than does a decimal representation.

Where the probabilities are not equal, Shannon has shown that the information content is:

Information content is defined simply as the logarithm of the total number of possible states or conditions of the variable.

$$H = -\sum_{i=1}^{n} p_i \log p_i \qquad 9$$

where p_i is the probability of the i-th event of n possible events. This equation becomes the same as equation 8 when all the events are equally likely (as is true of most measurement and control situations). This is because the sum of all the probabilities equals 1.

Information Content of Measurement Situation

To return to our system being measured, the total number of possible values the measurement can produce was given by equation 2 as

$$n = (y_m/\Delta y) + 1 \qquad 2$$

Of course, without previous knowledge of the process, we must say that any of the n possible measurements are equally likely—that is, the measurement can have any of the possible values. Thus, since the measurement can assume any of the n values, and all are equally likely, the probability of any one of them ocurring is

$$p = \frac{1}{n} = \frac{\Delta y}{y_m + \Delta y} \qquad 10$$

If we insert this into equation 8 we obtain the information content of one particular measurement in bits:

$$H = \log_2 n$$
$$= \log_2 \left[\frac{y_m}{\Delta y} + 1\right] \text{bits} \qquad 11$$

If we insert 3 into this equation we obtain the information content of a reading (in bits) in terms of the system's allowable error (in percent):

$$H = \log_2 \left[\frac{100}{2\epsilon} + 1\right] \text{bits} \qquad 12$$

This equation tells us the *information content in a single measurement of the variable in a static measurement.* In a dynamic state, the variable changes a detectable amount in a minimal time increment given by equation 7. Thus the maximum information rate (β), or rate at which information is to be recorded in a system, is given simply by $H/\Delta T$, and dividing 11 by 7, we obtain the information rate:

$$\beta = \frac{100}{2\epsilon T} \log_2 \left[\frac{100}{2\epsilon} + 1\right] \text{bits/sec} \qquad 13$$

This gives us the information rate in terms of the measurement error and approximate rise time of the system.

Digital Versus Analog Systems

Let us examine a typical recording instrument and evaluate its information-rate capability. This is a quantitative measure of the system in digital terms and offers a basis of comparing a digital system with an analog system.

Let us say we are to compare two systems. One is a digital system which can convert at a rate of 1000 times/second and produces 7 bits at each conversion. Its bit rate, or information rate, is then 7000 bits/second. Is this digital system equal to, better than, or worse than an analog recording system with the following characteristics:

Rise Time: 0.01 sec.
Linearity: 1%
Trace Readability: 0.5%
Response: 3%
Total possible error sum is thus

$$1\% + 0.5\% + 3\% \text{ or } 4.5\%$$

Here, the linearity is inherent in the measuring instrument; response error is always present and is determined by the natural frequency and damping ratio used. We first calculate the minimal time increment (for the variable to change a detectable amount) using equation 7:

$$\Delta T = 2(4.5)(0.01)/100$$
$$= 9/10^4$$

This is inserted, along with the other information, in equation 13 to obtain

$$\beta = \frac{10^4}{9} \log_2 \left[\frac{100}{2(4.5)} + 1\right] = \frac{10^4}{9} \log_2 12.1$$
$$= 4400 \text{ bits/second}$$

Thus, the bit rate of the digital system exceeds that of the analog system.

We can also look at this another way and assume an instrument has a fixed bit-rate capability of, say, 10,000 bits per second. There are innumerable combinations of rise times and total system errors that will have the same information rate. Specifically, if we carry out the computation above for a few cases we find the following combinations of rise times and system error all yield a bit rate of 10,000 bits/second:

Rise Time (sec)	System Error
0.015	1%
0.010	2%
0.005	5%
0.001	10%

For fixed information rate we trade system error for rise time. This same criterion can be used for evaluating the digital needs for a process if we have *a priori* knowledge of the system.

Determining the Requirements for a Known Process

If there is *a priori* knowledge of the process to be digitized, it is possible from the previous considerations to determine the multiplexing and conversion rates to record the process. Suppose a process has a rise time of 0.01 second and we wish to obtain digital information with an error of 1%. Using equations 2 and 3:

$$n = \frac{y_m}{\Delta y} + 1 \qquad 2$$

$$\Delta y = \frac{2\epsilon}{100} y_m \qquad 3$$

we combine these to obtain

$$n = \frac{100}{2\epsilon} + 1 \qquad 13$$

This determines the resolution of the system required. For our problem, this will be:

$$n = \frac{100}{2(1)} + 1 = 51 \text{ states}$$

A converter with 51 states is required. From the previous discussion of converters, it is evident that the number of states most convenient to use electronically is determined in powers of 2; thus we choose a system with 64 discrete states (a 2^6 or 6-bit binary code).

We are now concerned with the conversion rate, having established that each conversion is to be made to 6 bits. Use is again made of equation 7:

$$\Delta T = 2\epsilon T/100 \qquad 7$$

We require a conversion in the minimal time interval given by

$$2(1)(0.01)/100 = 2 \times 10^{-4} \text{ sec/conversion}$$

This yields a conversion rate of 1/0.0002, or 5000 conversions per second. As we have chosen 6 bits at each conversion, the system required is the product of the two quantities 6 and 5000, or a 30,000-bit-per-second rate. If we are to multiplex among several channels, each with the same rise time, it is a matter of patching the multiplexer so that each channel is visited at 0.0002-second intervals; the converter rate must be increased accordingly so that six bits are produced at each conversion. For example, to multiplex among three channels as above, we require that each channel be visited every 0.0002 second. There would be an interval of 0.0002/3 second (about 70 microseconds) between conversions and multiplexer steps.

In processes such as chemical processes or refineries, process rise times of longer intervals are common. Thus, a process with a 10-second rise time might need to be sensed to an error of 1%. Here again the 1% dictates a 6-bit system. However, the minimal time interval is greater:

$$\Delta T = 2(1)(10)/100 = 0.2 \text{ second}$$

Thus we require only 5 conversions per second. The bit rate of the converter is then 6 x 5, or 30 bits a second. One hundred inputs of the same sort would require only 100 x 5 or 500 conversions per second. The steps between adjacent channels would be 1/500 second, which would also be the required converter rate.

Information and Time

It is an intuitive matter to suggest that information is obtained linearly with respect to time. That is, as we progress in the reading of this book we may say that by the time we have read page 20 we have obtained twice as much information as was obtained when reading to page 10. At page 25 we would have 2.5 times as much information as we had on page 10. Here, of course, we leave quality of writing and distribution out and assume that the information is spread uniformly through the book.

Now suppose we write a message in binary code, where each word is coded in five binary numbers: 11011, 11111, 01001 and so on. There are 2^5 possible words we can use. Let a message consist of six words, thus allowing us $(2^5)^6$ possible messages. This is 2^{30} possible word combinations in a message. Obviously, a message of six words has considerably more than six times as many possible words than a single word. In our example the figures are 2^5 and 2^{30}. This does not appear to be consistent with our intuitive notion that information increases linearly with time. However, use of the logarithm adjusts these two features and brings them into intuitive harmony. Thus, in the latter case, the information is said to be proportional to 30 log 2, and in former case to 5 log 2.

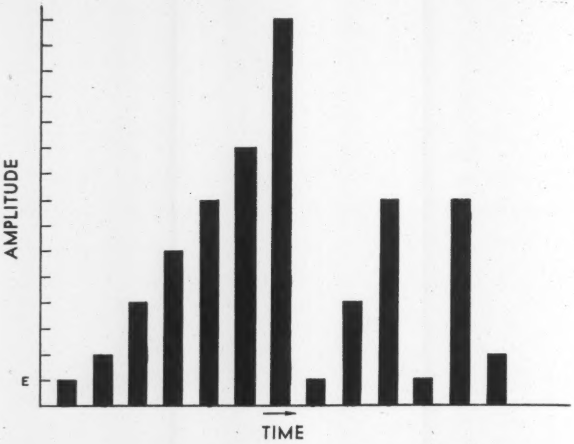

Fig. 10-2. Information sent in the form of pulses whose amplitude is a multiple of a unit height E.

To generalize, if we have S possible messages at each time interval, and n time intervals, and if the information is to increase linearly so that:

$$I = Kn \qquad 14$$

The number of possible messages is of the form

$$(S_1)^{n_1} = (S_2)^{n_2} = (S_j)^{n_j} \qquad 15$$

This says there are the same number of messages in six 5-bit words as in five 6-bit words:

$$(2^5)^6 = (2^6)^5$$

Thus, for the information to increase linearly in each case:

$$I = k_1 n_1 = k_2 n_2 \qquad 16$$

If we take logarithms of equation 15 and divide the appropriate side into equation 16 we obtain

$$k_1/\log S_1 = k_2/\log S_2 = K_0 \qquad 17$$

thus the information is given by

$$I = K_0\, n \log S \qquad 18$$

If we use logs to the base 2, we talk in bits ond obtain (after setting K_0, the constant of proportionality, equal to 1)

$$I = n \log_2 S \qquad 19$$

or

$$I = n \text{ bits} \qquad 20$$

of information

Let us examine how Hartley made use of this criterion to determine how much information could be transmitted over a channel in unit time.

Consider information sent in the form of pulses where there are S possible states of pulse height, unit height being a voltage E. This is shown in Fig. 10-2. The minimal pulse height is then E volts and the maximum $(S-1) \times (E)$ volts. For a circuit having simple exponential response, the current after time t of application of a pulse of height nE is given by

$$i = \frac{nE}{R} e^{-at} \qquad 21$$

The worse possible situation we can get into here is to transmit a maximum pulse whose value is $(S-1)$ (E) and then one of height E; we must be able to distinguish between the two if the smallest pulse follows the largest. Let the pulses be transmitted at fixed time intervals T, and if we send a train of maximum pulses, the residual current of the long train of maximum pulses is given by

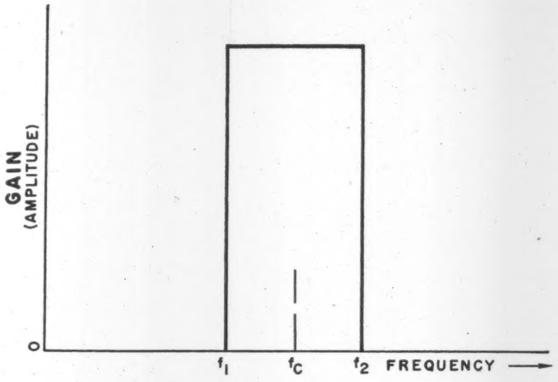

Fig. 10-3. Theoretically ideal bandpass characteristic of a filter network.

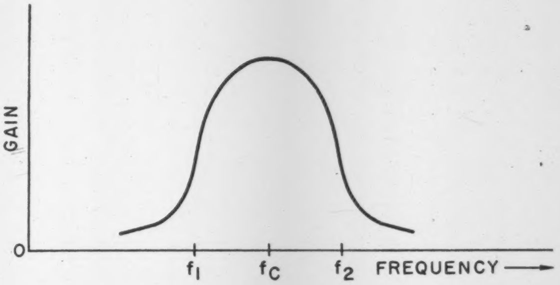

Fig. 10-4. Practical bandpass characteristic does not have perfectly vertical sides and horizontal top.

$$i = \left[(S-1)E/R \right] \sum_{q=1}^{\infty} e^{-q\alpha T} \qquad 22$$

If we make use of the infinite series expansion for the sum of a geometric progression, we can obtain from 22:

$$i = \frac{(S-1)\,E}{R} \left[\frac{1}{e^{-\alpha T}-1} \right] \qquad 23$$

But if we are not to interfere with the next minimal pulse, the residual current must be less than the minimal pulse current, which is

$$i = E/R \qquad 24$$

By combining 23 and 24 we obtain

$$S = e^{\alpha T}$$

which tells us the number of possible states the message may have in order to be transmitted without information being lost. As was pointed out, this number of possible messages is the measure of the information sent in the system. Therefore,

$$I = n \log_e S = n\alpha T = \alpha T \qquad 26$$

where n is the product of the number of pulses and rep rate and thus T is the message length.

The exponential coefficient, αT, is related to the type of network used where each network has some frequency-discriminating characteristic. An idealized frequency bandpass characteristic is given by Fig. 10-3 and a practical one by Fig. 10-4.

Let us represent the real bandpass network (such as in Fig. 10-4) by one of the type shown in Fig. 10-3 by finding a rectangle with a mid-frequency and gain product (area) equal to that of the real one. This is

$$\Delta f = (1/G_o) \int_0^{\infty} G(f)\, df \qquad 27$$

where G(f) is the gain or power transfer ratio at frequency f, and G_o is the gain at the reference frequency for the rectangular idealized network. If the circuit over which we are transmitting pulses has a single time-constant, the G(f) is given by

$$G(f) = \frac{1}{1 + \omega_2 C_2 R_2} \qquad 28$$

and if we substitute this into 27 we obtain

$$\Delta f = \frac{1}{4CR} = \frac{\alpha}{4} \qquad 29$$

By combining 26 and 29 we obtain

$$I = \alpha T = 4\,(\Delta f)\,T \qquad 30$$

So that in unit time

$$\beta = I/T = 4\,\Delta f \qquad 31$$

This was in natural logarithms. In $\log_2$:

$$\beta = 5.77\,\Delta f \qquad 32$$

which tells us that the maximum information rate for a single-time-constant network with an ideal bandpass characteristic (as in Fig. 10-3) is a number of bits per second given by 5.7 times the bandpass of the network. Conversely, 5.77 bits for each cycle of bandpass gives us the total information in the system. From this analysis comes the statement that for *each cps in a network, 6 bits per second are required to represent all of the information in the system.* Thus a 200-cps bandwidth signal would require 6 x 200, or 1200 bits-per-second information rate to obtain all of the information in the bandwidth. This is actually a greater value than is needed according to the analysis of Shannon. However, the advantage in this arrangement is that there is ordinarily a sufficient number of bits to identify a sine wave when this latter is converted by digital techniques into a pulse code and then the pulse code is reconverted back to discrete analog points.

How Many Samples per Second?

The general statement concerning sampling rates is due to Shannon and can be stated as follows:

> "If a function f(t) contains no frequencies higher than f cps, it is completely determined by giving its ordinates at a series of points spaced 1/2f seconds apart."

In other words, the rep rate of the pulse representation of the arbitrary function must be equal to twice the highest frequency in the function.

One can intuitively see this from a simple example. Suppose we are looking at a 5-kc signal for short intervals at a 3-kc rate. The resulting discrete points, if plotted, would appear to have a difference frequency of a 2-kc as well as a 5-kc frequency. This is much like the stroboscopic or heterodyning effect in which the sum and difference frequencies appear whenever two signals of different frequencies are "mixed."

But if we use a 12-kc rate to look at the 5-kc signal, the difference frequency is 7 kc, which is beyond the input frequency. If we introduce a filter so that all signals above

5 kc are eliminated, this 7-kc "stroboscopic" frequency is removed. Obviously, the rep rate must then be just in excess of double the signal being examined, here 5-kc, so that the difference frequency can be filtered out. This is consistent with Shannon's criterion.

In more general terms, let the waveform being examined last T seconds, with the highest frequency in it being f. Then the fundamental frequency in a Fourier expansion of the waveform will be 1/T, and the highest frequency will be the Tf-th harmonic.

As a Fourier expansion contains sine and cosine terms, having Tf harmonics means we will have 2Tf numerical coefficients which will then completely describe the function in terms of a Fourier series. We need to show, to prove Shannon's statement above, that if we space the discrete readings 1/2f time units apart, we will represent the 2Tf numerical coefficients which completely describe the function. To do this, we make use of the inverse Fourier transform, which takes us from the frequency distribution back to the original function much as the Fourier transform took us from the function to the frequency domain. This is

$$F(t) = (1/2\pi) \int_{-\infty}^{\infty} F(\omega)\, e^{j\omega t}\, d\omega \qquad 33$$

As the highest frequency was specified as f cps, so the highest permissible angular frequency, ω, is simply $2\pi f$. As the independent variable for which we are now solving, t, may take on any value, let us investigate the function at a time $t = n/2f$, where n is any integer. Then equation 33 can be modified to read:

$$f(n/2f) = (1/2\pi) \int_{-2\pi f}^{2\pi f} F(\omega)\, e^{j\omega n/2f} d\omega \qquad 34$$

with the change in limits made because the frequency was specified to not exceed f in the original problem. But since n/2f is the ordinate of the function at the nth of a series of points spaced 1/2f seconds apart, the specified ordinates of f(t) are the coefficients in a Fourier-series representation of $F(\omega)$ over the range f. By taking a sufficient number of samples and extending the time interval T, we may approach $F(\omega)$ in value as closely as we desire. The series of sample ordinates may be said to specify $F(\omega)$, which in turn, using equation 33, specifies f(t).

We have thus shown that the criterion specified by Shannon is valid with the restriction that the message time interval, T, must always be considerably greater than 1/f. In automation techniques this almost always is true.

In the preceding we have made a cursory examination of Information Theory as it applies to digitizing signals in automation processes. Shannon's basic criterion was described and its proof indicated heuristically. A simple technique to be used in terms of linear system response-time was also described so that we have means at our disposal to design a system on either frequency or response-time characteristics; the two can be equated by use of the Fourier transform.

Next month: Data Handling

Quantitative Analysis of Cascade Control

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RECENT trends in the processing industries toward increased process flows and reduced storage capacities have placed exacting demands on the control of process variables. Use of cascaded controls, in which the desired value of one controlling unit is dictated by the control action of another, is often indicated whenever higher than ordinary control performance is economically justified.

The results of this study are based on the simulation of the process and control system elements on an analog computer.

Successful simulation naturally depends on a knowledge of the process characteristics. These characteristics often are difficult to determine accurately—the degree of difficulty depending on the accuracy required. Experience has shown that, despite the complexity of most large physical systems, it is generally possible to approximate the characteristics of many processes to an acceptable degree.

In most physical systems there is usually one component whose time constant is large in comparison with the remaining time constants. This lag can be classified as a dominant lag and can be used to represent the dynamic characteristics of the series arrangement with acceptable errors. Generally, a ratio of time constants of 10:1 allows an approximation of the system characteristics by a dominant lag.

Optimum controller settings were determined by the ultimate sensitivity method. The ultimate gain (maximum loop gain causing sustained oscillations) and period of oscillation were determined on the computer. Using these values of ultimate gain and period, the approximate optimum controller settings were obtained by using the formula developed by Pessen[6].

The results of this study show that the control of many processes may be improved by the use of a cascade control system. The amount of improvement depends on the nature of the process.

One of the primary factors brought out by this study is the utility of the analog computer for solving industrial control problems. The analog computer makes it possible to set up and study complicated devices and systems. It provides quick answers to engineering problems and furnishes insight into and an understanding of system problems. Without its use the study reported in this paper could not have been made.

Abstracted from article of same name, in *Industrial & Engineering Chemistry*, June, 1956

[6] Pessen, D. W., "Optimum Three-Mode Controller Settings for Automatic Start-Up," Am. Soc. Mech. Engrs., No. 52-A-58.

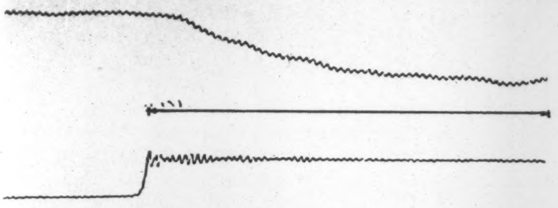

Fig. 1. Flow response (top curve) to an imposed step change (bottom curve); 60-cps "noise" on signal shows rapid response of the magnetic flowmeter used to make the measurement.

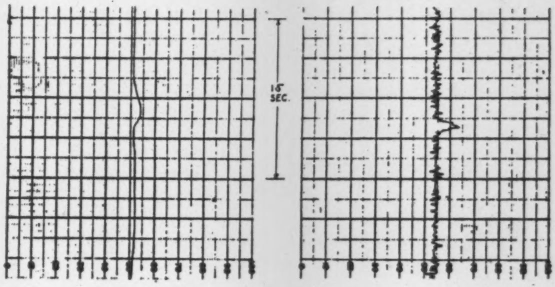

Fig. 2. Comparison of slow response of a mercury flowmeter transmitter (left) with a more rapid dry differential-pressure transmitter (right).

Dynamics of Liquid Flow Control

ALLAN R. CATHERON and **BRUCE D. HAINSWORTH**
The Foxboro Co.

FLOW CONTROL problems are somewhat different from other process control problems. Perhaps the most significant difference is that the liquid flow process has almost no capacity for the storage of energy. This almost total lack of energy-storage capacity means that the rate of flow is a direct function of valve stem position at any frequency below about 1 cycle per second.

In temperature or pressure control, however, there is always some storage of energy in the process; the measured temperature or pressure is then a time integral of the valve position. Thus high-frequency upsets pose more of a problem in flow situations.

The objectives must be to pass all the signals which represent actual variations of flow and to reject as many as possible of the spurious signals—in the language of the communications engineer, to achieve a high signal-to-noise ratio.

Analysis of literally miles of high speed charts led to the conclusion that most of the objectionable noise is at frequencies above 3 cycles per second; tests showed that controller performance was not seriously impaired by losing all frequencies above 3 cycles per second. Again using the vocabulary of the communications engineer, the signal can be filtered without harmful distortion.

It has lately been possible to obtain improved high speed recordings of the response of the flow in the test system to step-changes in valve position. The flow was measured with a magnetic flowmeter, which has a linear scale and which also eliminates "noise" caused by local pressure variations.

One of the records obtained in this way is shown in Fig. 1. The flow change is about 15% of the 100-gallon/minute scale, with the average level of operation at 55 gallons/minute. The small 60-cycle signal appearing in the flow record was left unfiltered purposely, as a check on the response of the measuring system.

These records indicate the considerable speed of response of such a process in comparison to that of conventional control equipments. Specifically, the flow record of Fig. 1, when approximated as a dead time followed by a single-capacity response, reads 0.06-second dead time and 0.22-second time constant.

Flowmeter Dynamics

The objective of the first of these flow control studies was simply to find out more about the nature of flow processes. The catalyst for these tests was a revolution in flow measurement in 1947, when the dry differential-pressure transmitter began to replace the mercury manometer, the old stand-by for flow measurement in the process industries.

The response of the mercury flowmeter is so slow in comparison with the other components of the flow control loop that, when the mercury manometer is used to measure the differential pressure across the orifice, the dynamic response of the whole flow control loop is, for all practical purposes, the response of the mercury flowmeter. When a mercury flowmeter is replaced with a dry differential-pressure transmitter, the nature of the control problem is entirely changed, because the measuring element is no longer the slowest component of the control loop.

The difference in measurement is shown in Fig. 2. Contrast the even, filtered record from the mercury flowmeter transmitter with the "live" response of a dry differential-pressure transmitter on the same orifice. Filtering can be carried too far!

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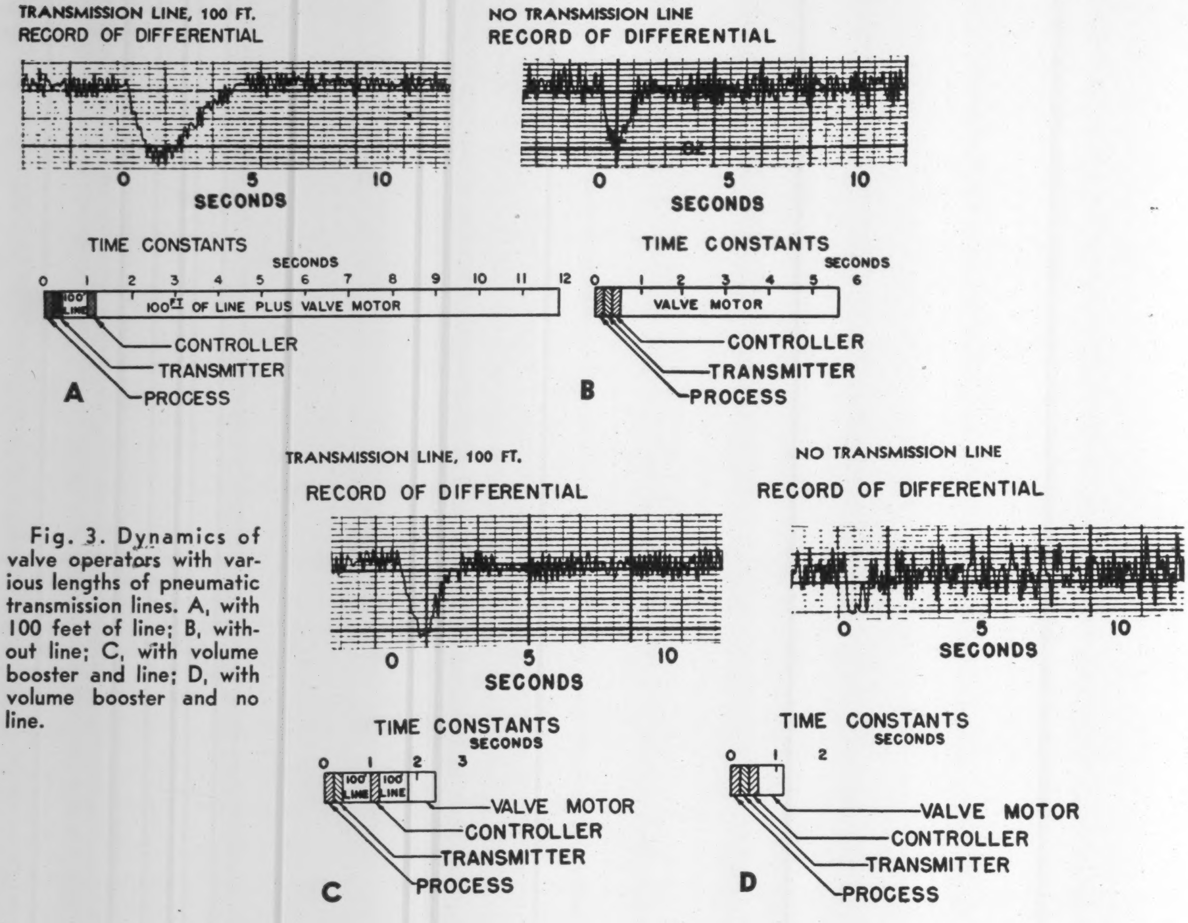

Fig. 3. Dynamics of valve operators with various lengths of pneumatic transmission lines. A, with 100 feet of line; B, without line; C, with volume booster and line; D, with volume booster and no line.

Valve Operator Dynamics

Measurements were made of the dynamics of control valve operators[3] with various lengths of pneumatic transmission lines. The figures show the relative effect of each of the system components, based on the recovery from a 10% load upset, and a bar chart of the summation of the time constants of each of the system components.

The first test (Fig. 3A) was made with 100 feet of 0.188-inch-i.d. metal transmission line from the differential-pressure transmitter to the controller, and 100 feet of transmission line from the controller directly to the 150-cubic inch valve actuator. Fig. 3B shows the improvement of control and the increase in speed of response afforded by eliminating the transmission line. Note that the dominant response lag is in the valve actuator.

The next step was to mount a volume booster, essentially a volume relay, on the valve actuator. The output signal of the controller (3 to 15 psig) is transmitted to the small volume (1.6 cubic inches) of the booster; the booster, with an air-handling capacity of about 14 cubic feet/minute, supplies the valve actuator with power.

Figs. 3C and 3D show the response of the systems of Figs. 3A and 3B when the volume booster is installed at the valve. The same 10% load upset is used. There is a marked improvement in control performance and a marked decrease in the lag attributable to the valve actuator (and its transmission line).

Comparison of the Figs. 3B and 3C shows that the system with the volume booster and 100 feet of transmission line gives nearly the same performance as the conventional controller mounted directly at the valve. This again bears out the fact that it is the large volume on the end of the transmission line that is most harmful—not the line itself.

Fig. 3C shows that the response of the transmission system now has a relatively greater effect, although not great in terms of time, on the dynamic response of the system. An effort was made, therefore, to develop a means of minimizing the effect of transmission-line lag.

Reducing Transmission-Line Lag

A theoretically possible means of minimizing transmission line lag is shown in Fig. 4. The output pressure of the controller or transmitter (input to the transmission line) is continuously compared with the output of the transmission line by means of an "instantaneous" feedback line. Any difference between the pressure applied to the transmitter and the pressure at the far end of the transmission line is amplified, and the amplified signal modifies the input pressure to the line in order to reduce the difference.

This device is impractical, but the use of an analog of the transmission line solves the problem neatly. Analysis based on the transmission line study[2] preceding this work showed that a two-capacity R-C network adequately approximates the dynamic characteristics of the line. This analog has the further advantage that the resistances are easily adjusted to represent different line lengths. The analog can be contained directly in the transmitter, where its output is readily compared to the input signal to the line. This construction is shown in Fig. 5.

Such devices (line-shrinkers) were built, tested, and successfully operated[5]. Dynamic performance was markedly improved, particularly for the longer transmission lines. Effectively, the device halves the length of the line. That is, a 500-foot line with a line-shrinker has about the same dynamic characteristics as a 250-foot line without a line-shrinker.

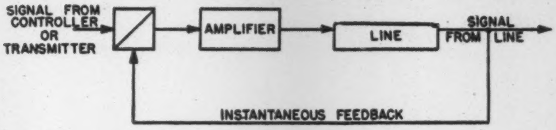

Fig. 4. "Theoretical" method for eliminating line lag compares output from line with input to line.

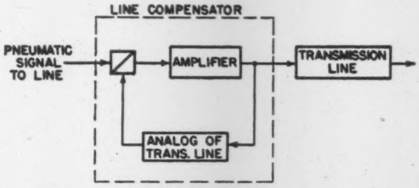

Fig. 5. Practical "line shrinker" uses R-C analog of line.

Control Valve Dynamics

The control valve was the subject of a study[4], although it was not a device that was modified. The plant gain and the valve characteristic are closely related: Plant gain is the change in the measured variable produced by a given change in valve stem position; valve characteristic is the relation between rate of flow and the valve stem position.

Even if the best valve is selected for a process, the plant gain may vary widely from the top of the scale to the bottom. Therefore, really optimum controller settings cannot be used because a controller adjusted for optimum response at one point on the scale may be either unstable or unresponsive at some other point.

Flow measurement inferred from the square root of a differential pressure aggravates this condition. The magnetic flow meter, which has a linear scale of flow response, shows a considerable improvement in uniformity of control response and permits the use of more nearly optimum controller adjustments.

Flow Controller Performance

When the change was made from the mercury meter transmitter to the dry differential type, the resulting shift in process characteristic called for a noticeable change in controller adjustments. The optimum proportioning band changed from about 20 to over 150%. The optimum reset times changed from about one half minute to perhaps one second. Control was much faster, yet equally stable.

A New Flow Controller

What had been learned about the characteristics of the flow process now led to a somewhat revolutionary approach to the design of a flow controller. Modern industrial controllers are provided with as many as three mode adjustments—proportional band, reset, and derivative. The function of these adjustments is to enable the operator to match the dynamic response of the controller to the process loop to be controlled.

The fact that the response of the flow line was so much faster than the response of other components of the loop suggested that mode adjustments are unnecessary for a controller on a liquid flow process. The response of the controller should be matched to the response of the rest of the control loop, but on a liquid flow process the response of the loop is the response of the auxiliary equipment in the loop—transmitter, transmission lines, valve operator. All these components are or can be furnished by the maker of control equipment, and as such are under his control and readily available for detailed analysis. This thorough dynamic analysis has been made, and only a limited range of variation was observed indicating that it was possible to select one set of controller adjustments that would function satisfactorily over the entire range. This meant that a controller without adjustments—one with fixed mode values—was practicable.

Such a controller was indeed devised[1], tested, and placed on the market. Experience has shown that it works successfully on liquid flow processes (for which it was designed) and on a wide variety of gas flow lines as well.

Perspective

A study has been made of the dynamic response of commercially available equipment for process flow control—the differential pressure transmitter, the pneumatic transmission lines, the controller, the pneumatic valve actuator.

In addition to adding to knowledge of the flow control loop, this study has led to a dry differential-pressure transmitter with a deliberately limited dynamic response, a device for reducing the time lags introduced by pneumatic transmission lines, a "universal" liquid flow controller, and a measurement of the improvement on control afforded by the use of volume relays to minimize the time lag introduced by the valve actuator. Thus, speed of response of the process control loop has already been pushed to the point where considerations of safety set a limit on rates of closing of valves in large, high-velocity flow lines.

Knowledge of the real character of flow measurement is still limited, and work continues on identifying and clarifying the mass of data made available by high speed pressure pickups and the magnetic flowmeter. The final determination of a boundary in frequency between useful data and noise, the nature and cause of the noise itself, and the effect of noise on control—these are questions that remain for the future.

Literature Cited

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2. Bradner, Mead, *Instruments* Vol. 22, 618-25 (1949)
3. Catheron, A. R., *Ibid.*, 24, 705-10 (1951).
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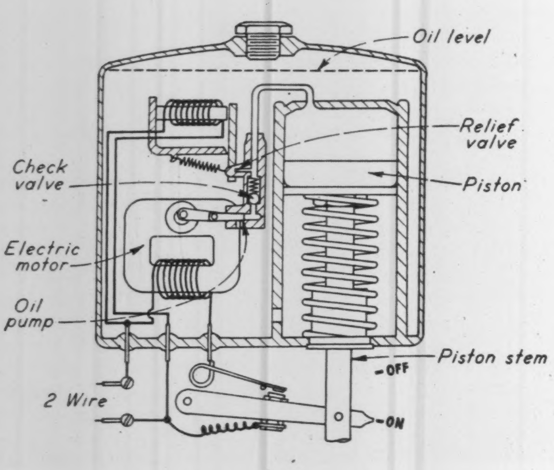
Control Valves—No. 8

Combination Actuators—

Electropneumatic, Electrohydraulic, Pneumohydraulic

Use of combination electric-pneumatic-hydraulic techniques makes possible the optimum use of all facilities to achieve the desired response characteristics. The power and response advantages of hydraulic media are giving emphasis to actuators with integral hydraulic pumps. Valve position on loss of power also is discussed.

C. S. BEARD
Foster Engineering Company



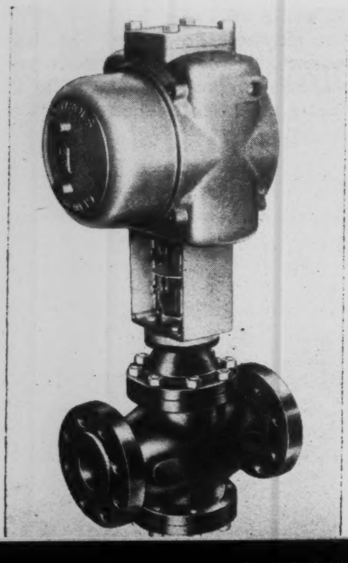


Fig. 8-1. Self-contained hydraulic actuator contains electric-motor-driven pump, oil reservoir, and piston for driving valve stem.

Actuators with Hydraulic Pumps

Use of hydraulically-operated cylinder actuators for positioning valves which operate with high unbalanced forces was discussed in the previous chapter on cylinder actuators. Throughout that discussion it was assumed that a source of high-pressure oil or water was available at the valve location. The distribution system for the liquid becomes a problem for isolated valves. The use of a local pump, powered either by an electric motor or gas or liquid from the line itself, becomes an important alternate.

Electric current can be used to operate a small high-pressure oil pump (Fig. 8-1). The electric-motor-driven pump supplies high-pressure oil to move the piston connected to the stem of the valve. When the stem moves to the full "down" position, it holds until the small magnetic relief valve allows the pressure to be dissipated so that the spring can move the valve in the opposite direction. Loss of current allows the spring to open the valve. A circuit has been developed to obtain throttling action from this unit.

The motor driving the pump that furnishes hydraulic power can be a reversible positive-displacement type so that fluid is taken from one side of the cylinder and forced into the other side to reverse the action. Limit-sensing devices must be used to stop the motor or to operate valves that shut off the fluid lines.

Fig. 8-2 shows a system wherein line gas is used to operate the oil pump. A packaged unit is available which uses gas from the transmission line to operate the prime mover for the pump. The gas is used also for operation of the control equipment so that no "instrument air" is required. Using a four-way pilot valve, the fluid forced out by movement of the piston returns to a sump from which the pump takes suction. A valve positioner is used to operate the four-way valve so that throttling action is obtained from the control valve. A small hand pump can

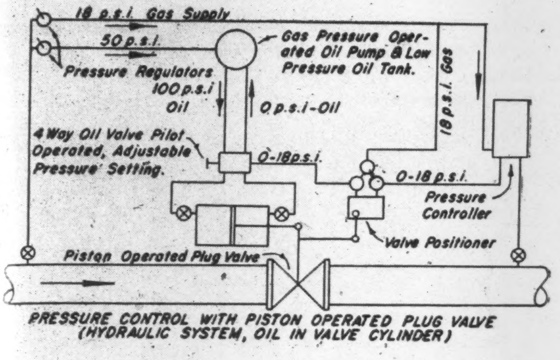

18 p.s.i. Gas Supply
50 p.s.i.
Pressure Regulators
Gas Pressure Operated Oil Pump & Low Pressure Oil Tank.
100 p.s.i Oil
0 p.s.i-Oil
18 p.s.i. Gas
4 Way Oil Valve Pilot Operated, Adjustable Pressure Setting.
0-18 p.s.i.
0-18 p.s.i.
Pressure Controller
Valve Positioner
Piston Operated Plug Valve
PRESSURE CONTROL WITH PISTON OPERATED PLUG VALVE
(HYDRAULIC SYSTEM, OIL IN VALVE CYLINDER)

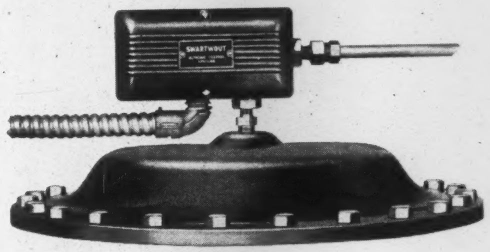
Fig. 8-2. Gas supply is used to actuate the oil pump for this cylinder-operated plug valve. Four-way pilot valve controls oil pressure to cylinder.

be furnished for manual operation. High speed and stability can be obtained with a system using an oil pump at the valve because the system requires displacement of only a small volume of fluid to move the piston. Short, small-diameter lines and high fluid pressure is used to keep the cylinder diameter at a minimum.

Electropneumatic and Electrohydraulic Transducers

The advent of electronic control systems has resulted in the design of units which translate the electric signal output of the control system into a form of energy suitable for actuator operation. Fig. 8-3 shows an electropneumatic transducer which transforms an electrical input signal into a corresponding and proportional pneumatic output signal. The electric signal moves a coil in a permanent-magnet field to position a small non-bleed pilot. The change in pressure created by the non-bleed pilot is directly proportional to the electrical output of the controller. The unit shown produces an output of 3 to 15 psig for a direct-current change of 4 to 8 milliamperes. The 3-to-15-psig variations of air pilot pressure can be used to position a larger capacity relay which supplies loading air to the actuator. Hence this electromechanical transducer, by positioning a pilot valve, becomes an electropneumatic transducer.

The electrohydraulic system shown in Fig. 8-4 also uses an electromechanical moving coil in the field of a permanent magnet. The coil positions a jet pipe that can



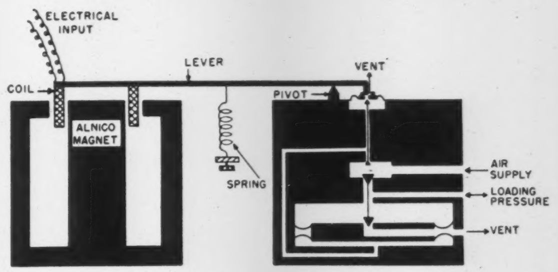
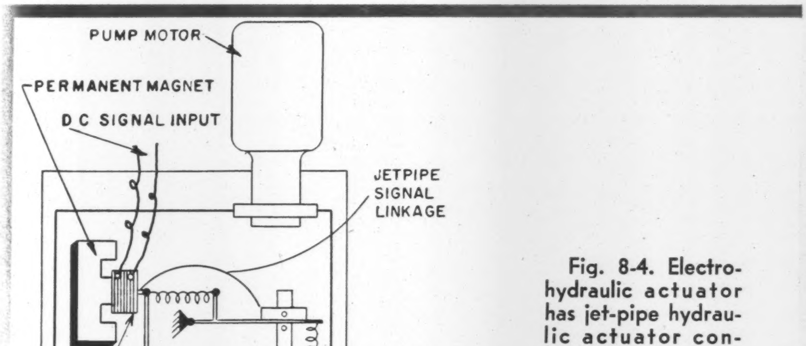

ELECTRICAL INPUT
LEVER
VENT
COIL
PIVOT
ALNICO MAGNET
SPRING
AIR SUPPLY
LOADING PRESSURE
VENT

Fig. 8-3. Electropneumatic transducer transforms the electrical input signal into a proportional pneumatic output signal. Input signal moves coil which positions pneumatic pilot.


PUMP MOTOR
PERMANENT MAGNET
D C SIGNAL INPUT
JETPIPE SIGNAL LINKAGE
ACTUATING CYLINDER
JET PIPE
OIL SUMP
STEM COUPLING
COIL

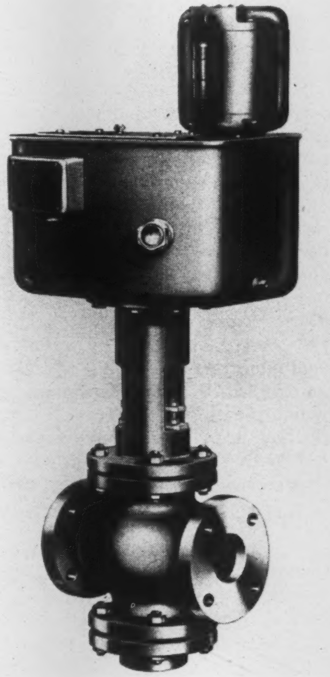
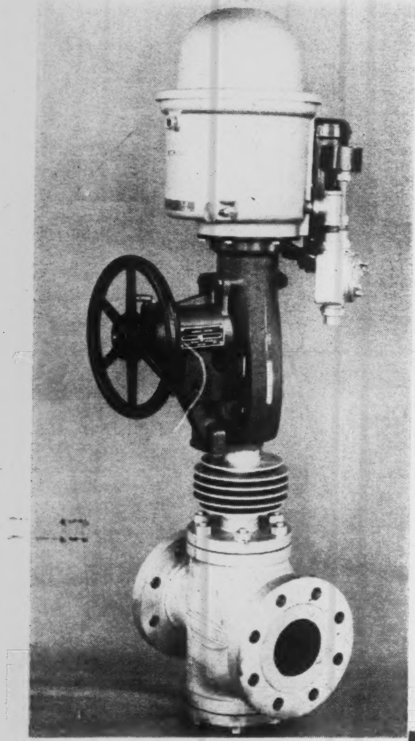


Fig. 8-4. Electrohydraulic actuator has jet-pipe hydraulic actuator controlled by moving coil.



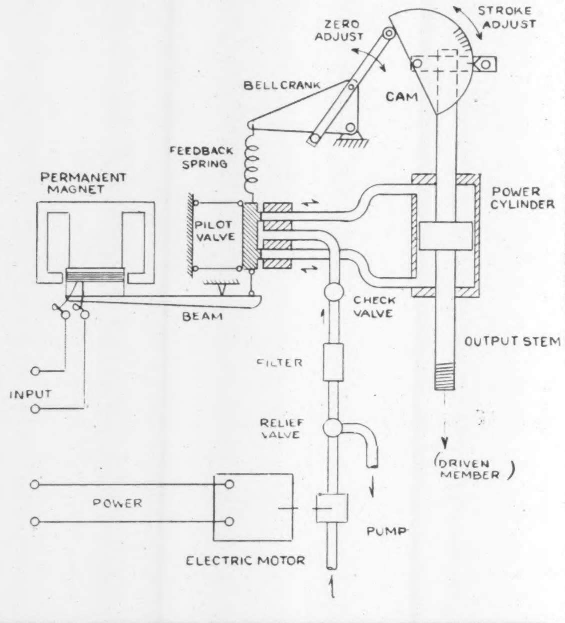


Fig. 8-5. This electrohydraulic actuator uses a moving coil to position a pilot valve controlling the direction of flow of high-pressure oil to cylinder.

direct oil under high pressure to one end or the other of the cylinder actuator. The pressure maintaining system position is not changed until the electrohydraulic transducer dictates another change (the jet remains slightly off center). The force output of this system depends on the pump characteristics and size of cylinder. The components shown in Fig. 8-4 are parts of a unit that can be mounted on a valve in the same manner as any other actuator. The unit then becomes an electrohydraulic valve actuator.

Another electrohydraulic actuator (Fig. 8-5) also uses an electromechanical transducer (moving coil and permanent magnet) to position a pilot valve. The pilot controls the pressure to the appropriate side of the piston in the power cylinder. Mechanical feedback senses the piston position and moves the pilot valve to lock in the pressure. This equilibrium position is maintained until the control system sends a different signal to the input coil.

Fig. 8-6 shows a hydraulic pilot positioned by an electric force (linear) motor which reacts to the differential-current output of an amplifier. This differential current energizes two opposing coils of the motor to position an armature. The armature is connected to a pilot piston which positions the hydraulic pilot to supply pressure to the actuator. The electrical output of the controller is fed to the amplifier which also receives a corrective response from a stem position sensor.

Valve Position on Loss of Motivation Power

One aspect of the selection of an actuator should be discussed at this point so the engineer can include this factor in his thinking when selecting a control valve and actuator. This is the question of what happens to the valve if the motivation medium for the actuator is cut off?

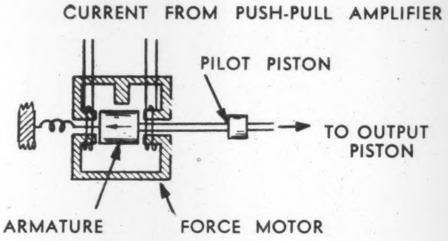
Three conditions of valve position are possible: The valve can either (1) go to wide-open position, (2) go to closed position, or (3) remain at the position it is in at the time that power is lost. The determination of which of these conditions is safest or most desirable is often more difficult than selecting the valve combination to comply with the decision. The following rules are often true: (1) Valves controlling coolant should open wide in most cases. (2) Most heating applications are safer if the valve closes to shut off fuel supply. (3) Maintaining a "status quo" usually is desirable in a plant in which shutdown affects a large number of related operations or, as is true in one nylon plant, solidification of the product occurs if pumps and heating are stopped.

Spring-loaded actuators tend to move to a position in which the spring is not under tension or compression; it follows that a valve which is closed by air pressure will open on loss of air, and a valve that is opened by air pressure will close. Various combinations of valve action and actuator action are possible, as has been explained in previous discussions.

Valves in which the line pressure must be overcome for closure will open if the closing force is removed.

Springless actuators will assume a position in which an equilibrium is maintained between the force exerted by the differential pressure across the valve seats and the force contributed by the weights of the parts. Friction in the packing will inhibit movement in any direction.

The final "status quo" position can be maintained in event of loss of instrument air by using a pressure-sensing switch to close a valve in the air line to the diaphragm so that the existing pressure is locked in when the switch is tripped. The switch is set to operate when the pressure in the instrument air system falls below a safe limit, indicating failure of the compressor or a break in the line.



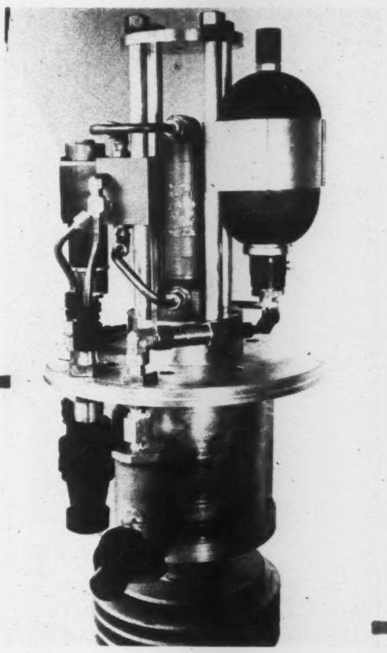


Fig. 8-6. Electrohydraulic actuator in which force-motor armature positions pilot piston which controls output piston.

Solenoid "lock-up" pilot valves can be used to operate under any emergency conditions which can be detected by electrical means. This method assumes that there is no leakage from the locked-in system, or that an auxiliary capacity is available for emergency use.

Cylinder actuators which are spring loaded will react the same as spring-loaded diaphragm actuators. The pneumatically-operated cylinder in which pressure is introduced at one end to move the piston in one direction and at the other end for reversal, will position the valve on loss of pressure at some intermediate point depending on the forces involved. The greater the friction of the piston seal, the slower any change in position will occur. If a four-way pilot valve with a dead spot (position in which all ports are closed) is used, the valve could remain in one position; this would occur if the position of the main valve is such that the control system is at equilibrium. The effect upon a package system would be the same as for loss of pressure in a distribution system delivering hydraulic fluid.

Certain valves, such as plug cocks or valves requiring a rotating spiral-thread stem, maintain their position upon loss of current (in an electric motor) or pressure (in a gas motor). The gearing used to adapt these motors to butterfly, Saunders-patent, or globe valves usually includes a self-locking worm and worm gear which will not allow a change in position of the main valve.

The soft-iron core of a packless solenoid valves will tend to drop in event of loss of power. The valve shown in the previous chapter in Fig. 7-1 closes tightly if the flow is from left to right, and floats at some intermediate point if the flow is between the seats. Springs are used to obtain the desired position upon loss of current.

Although locking the stem of a valve of the non-rotating stem type is the most straightforward approach, such locking devices are difficult to design and few are available.

The following summarizes the usual reaction to loss of energizing power:

1. A globe valve may open, close or float at an intermediate position.
2. Pinch, rubber sleeve, and Saunders valves will open.
3. Valves with screwed or geared stems or high friction (such as the plug cock) will remain in the same position.
4. Butterfly valves will float at an intermediate position.
5. Packless solenoid valves will tend to assume the position that occurs when the iron core is at the bottom of its stroke. The flow through the valve may, depending on its relation to the main valve, assist in closing or opening.

Actuators also have inherent tendencies to seek a position.

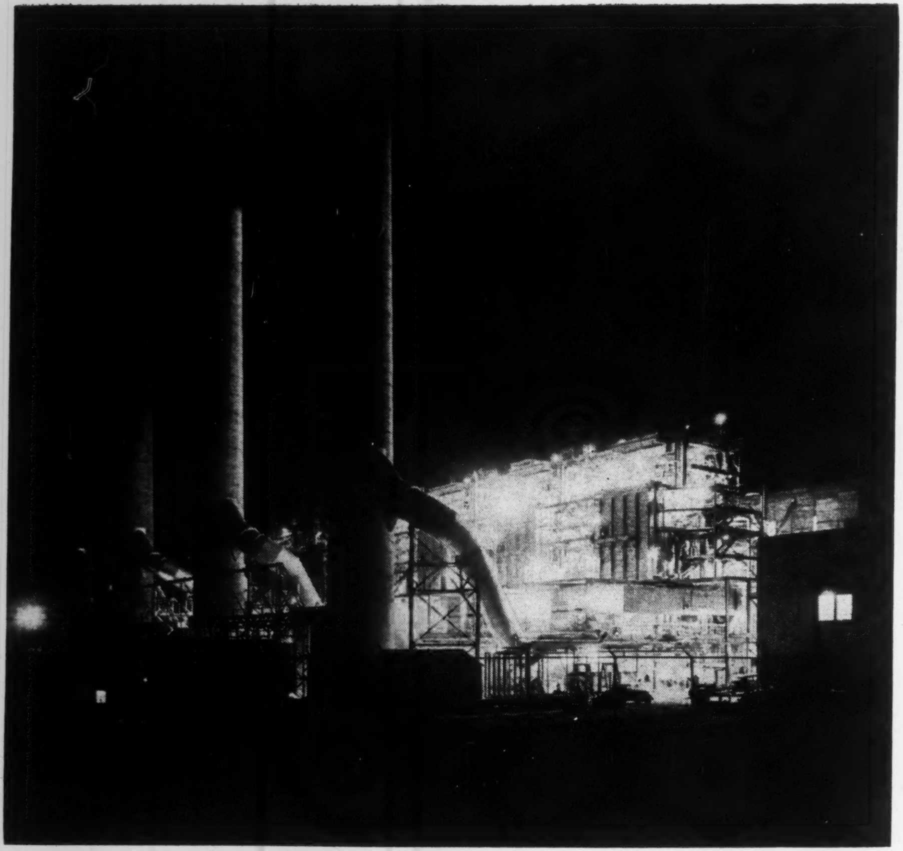
1. Pneumatic spring-loaded actuators will move to the position dictated by the expanded spring.
2. The gearing of most electric actuators will cause the stem to assume a status quo.
3. Springless diaphragm actuators will assume a position depending on the effect of pressure drop across the valve and the weight of the parts of valve and actuator.
4. Pistons controlled by a four-way valve with a null position could remain in position if the system were in balance, or could go whichever way the position of the four-way valve ports were positioned.

Selection of an Actuator

Selection of an actuator must be based upon knowledge of the system in which the valve is to be used, the type of valve body, and familiarity with actuators which have been discussed. A few points to be considered are listed.

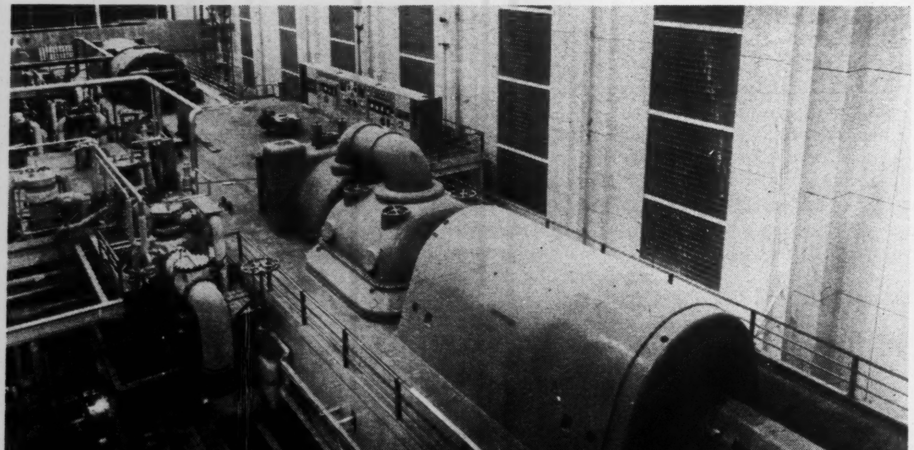
1. Motivating power available.
2. Safety precautions which may eliminate certain forms of motivating power.
3. What happens on loss of motivating power.
4. Type of actuators which can be used with the valve body to be used.
5. Force necessary to operate valve.
6. Length of stroke.
7. Speed of movement required.
8. Characteristics of actuator as related to type of controller to be used.
9. Temperature and quality of atmosphere at location of installation.
10. Importance of having full power available through entire movement of valve.

Selection will be described in greater detail in a following chapter.

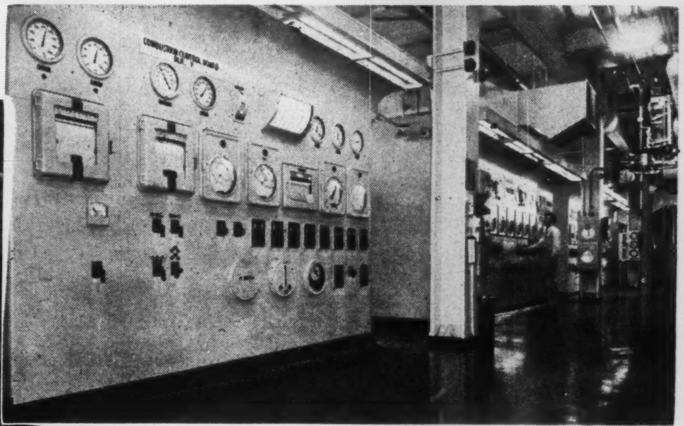


"Redondo" at night.

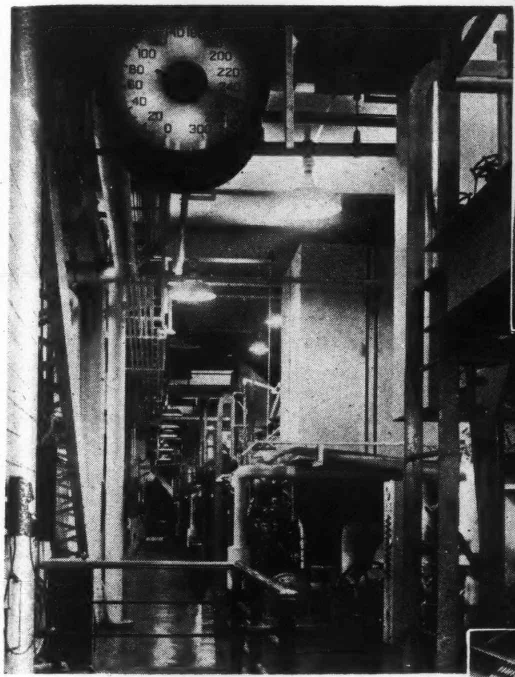
Power ⇄ Instrumentation



Two of the four turbogenerators presently in operation, which have a total capacity of 288,000 kw; more capacity is being added. That's big machinery. Men operate it—but instruments control it from the central control board, each of which controls 2 units.

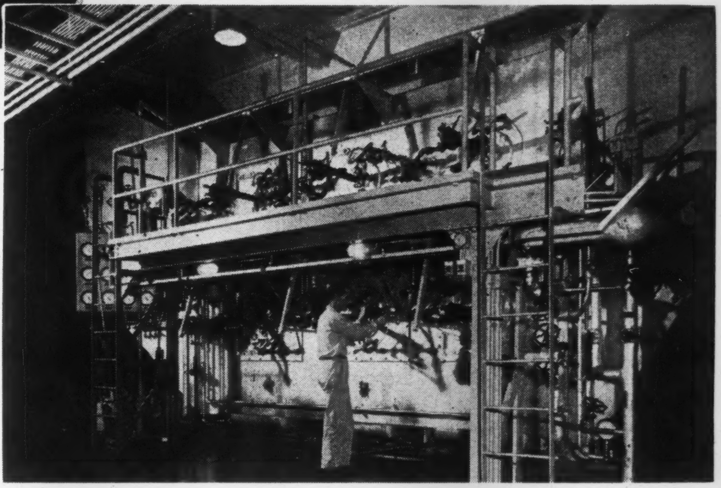


One combustion control board like this controls the fuel and oil to each burner.

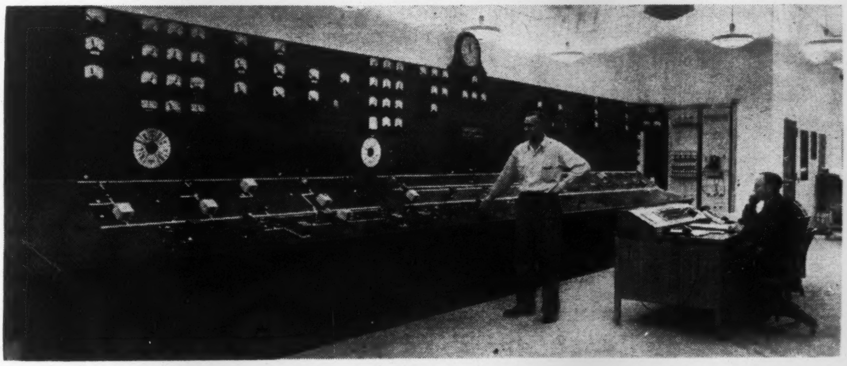


View from one end of the main boiler firing aisle. Load totalizer shows that Redondo was generating 250 megawatts of electricity at the moment picture was taken.

ON PAGE 1505 you met Henry Bennett of the Southern California Edison Company. Here is some of the instrumentation at the Redondo Steam Station of his company, showing how instruments control steam-electric generating facilities.



An Edison worker checks a burner under one of the big boilers.

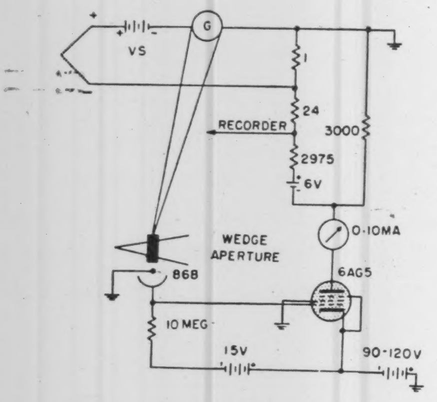


Dispatchers see that electricity goes over the proper lines to the proper loads in proper amounts.

SCALE EXPANDER FOR RECORDING POTENTIOMETER USES PHOTOELECTRIC FEEDBACK AMPLIFIER

This amplifier was devised to increase the sensitivity of a standard recording potentiometer having 25-mv full-scale sensitivity to obtain full-scale deflection from 0.5-mv input. In the circuit, T is a thermocouple, VS a variable millivolt reference source, and G is a voltage-sensitive mirror galvanometer with sensitivity of 0.88 uv/mm.

The principle used is as follows: The TC emf causes the mirror to move, changing the photocell emf. This emf is amplified and the amplified current is used to return the mirror to its original balance point (as in conventional self-balancing degenerative circuits). The balancing current passes through a 1-ohm and 24-ohm resistor in series. The 1-ohm resistor is across the TC; the 24-ohm and 1-ohm resistor are across the input to the recorder. Thus the recorder input is 25 times the emf generated across the 1-ohm resistor.



Light reflected from the galvanometer mirror passes through a wedge aperture to fall on the type 868 photocell. Because of the wedge, cell illumination is proportional to galvanometer deflection. Voltage developed by the photocell current across its 10-megohm load resistor is applied to the 6AG5 pentode grid. Plate current of the pentode flows (depending on its grid voltage) through the 3000-ohm resistor and through the parallel path made up of a 6-v battery, and the 2975-ohm resistor in series with the 1- and 24-ohm precision resistors. The circuit is polarized such that any voltage across the 1-ohm resistor (caused by 6AG5 plate current) will cause the galvanometer to deflect to *reduce* this voltage. Thus the feedback is negative; gain around the feedback loop is 115.

Suppose that the voltages of the thermocouple T and the voltage source VS are exactly balanced, and that the galvanometer G is in equilibrium position with light falling on the wedge. If the 6-v battery is now connected, current will flow through the loop consisting of the four resistors, and a voltage will appear across the 1-ohm resistor. This voltage produces deflection of the galvanometer; the pentode bias is now adjusted until it draws current (2 ma) to exactly balance the 6-v battery, reducing the voltage across the 1-ohm resistor to zero, centering the galvanometer. Output voltage is also zero for this condition, as there is no current in the 24-ohm resistor either.

Suppose now that the temperature of one element of the thermocouple is raised, so that the thermocouple voltage is 0.5 mv higher than the reference voltage VS. Then the galvanometer will deflect, changing the incident light on the photocell, and hence the bias on the pentode. Plate current of the pentode will change, changing the current through the 1-ohm resistor until a voltage of 0.5 mv is developed across it, opposing the thermocouple voltage. Actually, not quite 0.5 mv is developed, as some current must flow in the galvanometer to produce output across the 1-ohm resistor.

ELECTRONIC

CHARLES F. KEZER
Key Electric Corp.

and

MILTON H. ARONSON
Instruments & Automation

As the recorder output is taken across both the 1- and 24-ohm resistors, output is 25 times the input, or a gain of 25.

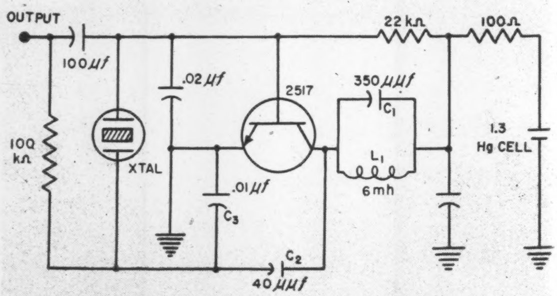
Voltage Gain: 25

Power supply: —90 to —120 v dc at 2 ma quiescent; 6 v dc battery at 0 ma quiescent; and adjustable 0 to —1.5 v dc bias. Heater supply 6.3 v at 0.3 a.

Source: W. Grattidge, General Electric Research Laboratory, Schenectady, N. Y.; also *Review of Scientific Instruments*, October, 1954.

TRANSISTOR FREQUENCY STANDARD HAS STABILITY OF 3 PARTS IN 10^9 PER DAY

Frequency drift of only 3 parts in 10^9 per day was obtained in tests of this compact battery-operated frequency standard. A single type-2517 junction-transistor oscillator operates with a high-precision GT-cut crystal to produce 100-kc output frequency. Battery power is obtained from a self-contained 1.35-v mercury cell. Cell life, under continuous operation, is over five years.



CIRCUITRY

The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

The transistor is connected for grounded-emitter operation, and develops 0.8 v across the tuned circuit. Collector-voltage limiting produces excellent amplitude stability.

Variations in phase shift, which in turn might produce frequency variations, were "swamped" out by connecting large value capacitors to the crystal terminals (0.01 and 0.02 uf). Temperature drift is 1 part in 10^9 per C°. For tests, the entire oscillator was immersed in a flask containing crushed clear ice. This is easily done as the entire unit was constructed in a metal tube 7″ long by 2″ diameter.

Frequency: 100 kc.
Temperature Drift: 1 part in 10^8 per C°.
Supply Voltage Sensitivity: 1 part in 10^8 per 0.1 v.
Frequency Stability at 0°C: 3 parts in 10^9 per day.
Power Supply: 1.35 v at 100 ua dc.
Source: Peter G. Sulzer, National Bureau of Standards, Washington, D. C.

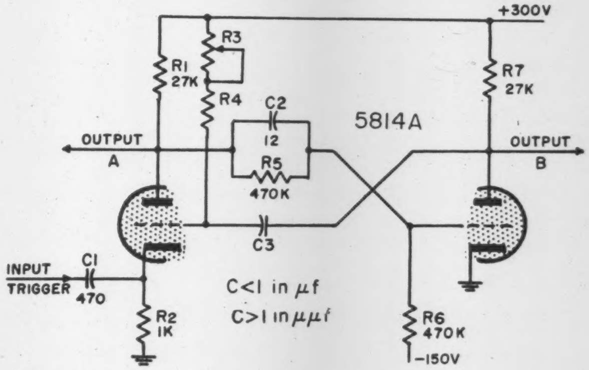
MONOSTABLE MULTIVIBRATOR

Positive or negative gate pulses are generated by this circuit, which was developed as a "main gate" multivibrator for radar applications. It is NBS-BUAer Preferred Circuit PC 41

The tube is a type 5814A miniature dual triode, a rugged type having superior resistance to shock and vibration. Left-hand half of the tube is normally conducting, as its grid is returned via resistors R3 and R4 to the positive supply. Plate of this triode is direct-coupled to the grid of the right-hand half section through the voltage divider R5-R6. Capacitor C2, across R5, speeds up the switching action; it is large enough to match the input capacity of the right-hand triode. If C2 were too large, the voltage rise at output A would be delayed.

Plate of the right-hand triode is coupled back to the grid of the left-hand section via the timing circuit, made up of C3 and R3-R4. These components must be temperature-stable when the circuit is used in applications requiring stability of gate duration.

When the left-hand triode is in its normally conducting state, its plate voltage is low (90v) and the grid potential of the right-hand triode is below cutoff. Plate of the right-hand triode is thus at the 300-v supply potential. When a positive 25-v trigger is applied to the input, the left-hand triode is cut off, as its cathode potential is raised momentarily above its grid potential, and the timing cycle begins. Plate potential of the left-hand section rises, bringing the left-hand triode into conduction. The corresponding drop in plate potential (210 v) of this tube drives the grid of the left-hand section well beyond cutoff, to remain non-conducting until the charge on the timing capacitor C3 has leaked off via resistors R3-R4. When the left-hand triode begins to conduct, regenerative action takes over and rapidly returns the circuit to the quiescent, or normal, condition.



Gate duration is determined by the time constant (R3 + R4)-C3. If R3 + R4 is made equal to 2 megohms, time duration in usec is equal to the value of C3 in uuf. Normally, duration would be changed by switching to different values of C3, with initial adjustment made by R3. For convenient adjustment, R3 should be made equal to about ¼ R4. R3 + R4 should be kept within the range of 550K to 3 megohms for best results.

Rise and decay times shown below were obtained with oscilloscope probe having 15-uuf capacitance. Larger external shunting capacitance than this will, of course, increase rise and decay times. Output A should not be connected to an external circuit which draws grid current, as this may interfere with the multivibrator action. In such circuits, an isolating buffer amplifier or cathode follower should be used.

The source of input triggers should provide positive pulses having rise time of 0.5 usec or less, at low impedance. Normally a blocking oscillator would be used to provide these trigger pulses.

Input: Positive pulses, 25 v amplitude.

Gate Duration: 30 to 2500 usec; maximum duty cycle 0.85.

Output A: Positive gate, 210 v peak. Rise time, 2 usec; decay time 1 usec.

Output B: Negative gate, 210 v peak. Rise time, 0.7 usec; decay time, 10 usec.

Stability: 5% change in plate supply voltage changes duration 0.8%; 10% heater voltage change produces 0.5% change in duration.

Power Supply: 7.8 ma at 300 v dc, 0.3 ma at —150 v dc, and 0.35 a at 6.3 v ac.

Source: NavAer 16-1-519, *Handbook of Preferred Circuits*, Navy Aeronautical Equipment, National Bureau of Standards, Washington, D. C.

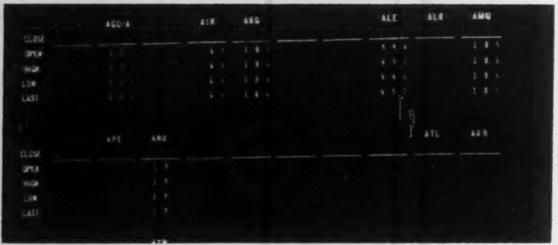


Fig. 1. Section of typical quotation board used by over 400 brokerage houses in the U.S.A. to display stock prices. Equipment is owned and operated by Teleregister. Prices emanate from a central transmitting station in New York City, and changes appear on boards within seconds after they are quoted on the New York Stock Exchange.

Fig. 2. Cabinets installed in offices of broker members of the Toronto Stock Exchange automatically display current bid and asked prices on any fifty of the most active stocks selected by the broker.

Magnetronic Data Handling

The automatic stock exchange, automatic reservation system, automatic warehouse, automatic inventory, and automatic bank show how the demands for rapid handling of vast quantities of data are met via automatic data handling systems.

DANIEL LAUGHLIN
The Teleregister Corporation

AMERICA is only beginning to appreciate the potential of its vast economy. Estimates of production and population demands are constantly being revised upwards. All evidence suggests unprecedented expansion in every field of production and economic activity.

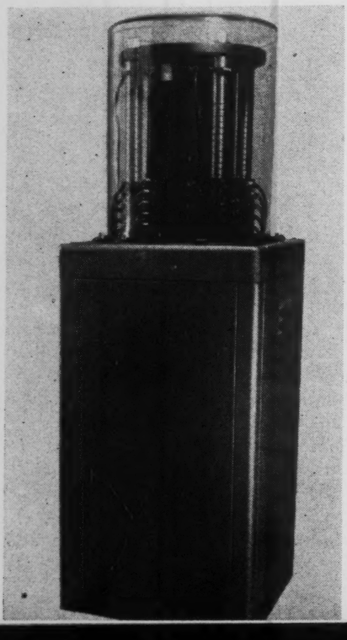


Fig. 3. Vertical magnetic data storage drum at the Toronto Stock Exchange, used for storing bid and asked prices.

A primary index of such activity is the increasing volume of data that must be handled, and the increasing speed with which the data must be handled. For example, we have reached the point where manual handling of stock and commodity transactions, airline and rail reservations, inventory control data, banking transactions, air traffic situations, weather reports, etc., etc., is not only inefficient and uneconomic but dangerous as well. The following typical automatic data-handling systems show the modern approach to today's needs—and anticipate tomorrow's demands. Examples will be given of (1) automatic stock and commodity exchanges, (2) automatic reservation systems for airlines and railroads, (3) automatic warehousing and inventory control systems, and (4) automatic banking systems.

Stock and Commodity Exchanges

The Teleregister Corporation has a central transmitting station at 480 Canal Street, New York, N. Y., serving nearly 400 stock and commodity exchange boards throughout the country. These electric quotation boards display quotations from the nation's leading exchanges. Electric impulses transmitted by direct wire actuate relays on the local boards (Fig. 1). This system, developed by

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Presented at the Computer Clinic, Second International Automation Exposition, Chicago, Nov. 14-17, 1955.

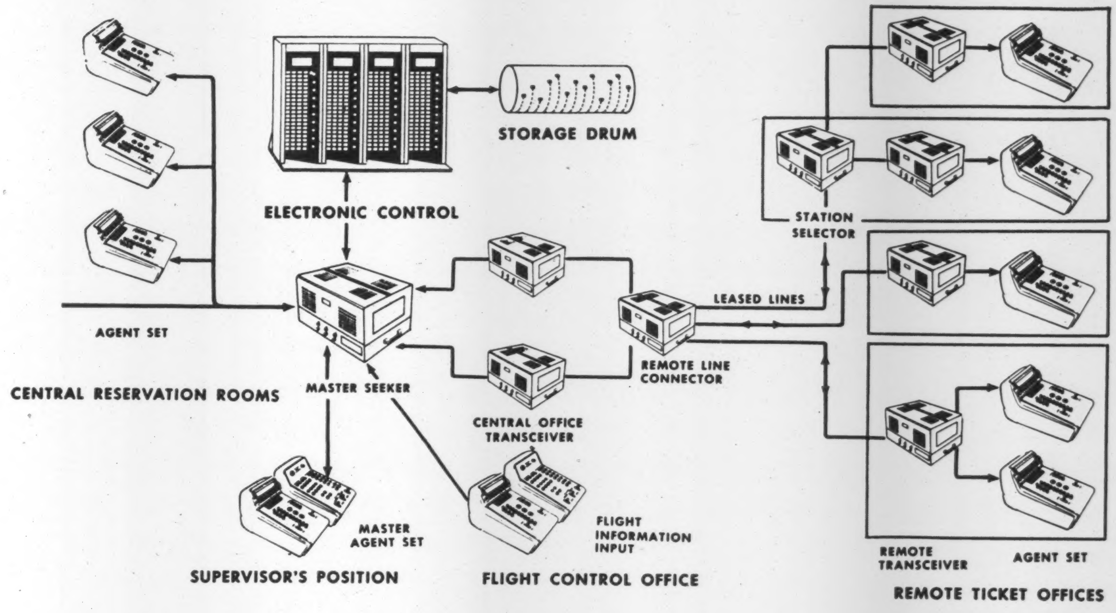


Fig. 4. Magnetronic Reservisor system has been handling reservations for American Airlines for four years.

Teleregister more than 25 years ago, has evolved into a true data-processing system by the addition of storage and feedback devices, as examplified by the Toronto Stock Exchange.

Toronto Exchange

In 1947, stock brokers in Toronto sought a means whereby they could select and obtain bid and asked prices on certain stocks that they could select at will. Teleregister developed a remote input-output device operated by a dial selector to solve this need. The stock broker need only dial a code number; the impulses travel by wire into the Teleregister center storage system in Toronto. Within seconds a printer will print out, automatically, the bid and asked price as well as the serial number of that stock (for confirmation.) This permits automatic printout of data, on demand.

Fig. 2 shows a typical cabinet that can be used in the broker's office. Any fifty active stocks can be selected by the broker. The interrogating impulses cause information stored on magnetic drums (Fig. 3) to be relayed back to the interrogator and automatically displayed on the board shown in Fig. 2.

Airline Reservations

Shortly after the war, American Airlines sought a means whereby agents in reservations offices could obtain rapid information regarding the availability of space on scheduled flights. The existing system required the agent to scan a large wall display board, a time-consuming operation subject to human error. Some features of the Toronto system were used to solve this problem; the result was the Magnetronic Reservisor.

Magnetronic Reservisor—American Airlines

The Magnetronic Reservisor installed in 1953 for American Airlines represented a milestone in the handling of reservations in the air transport industry. The equipment (Fig. 4) makes it possible for a reservation clerk or ticket agent to determine the availability of space, within seconds, on up to 1000 flight legs per day for a 12-day period.

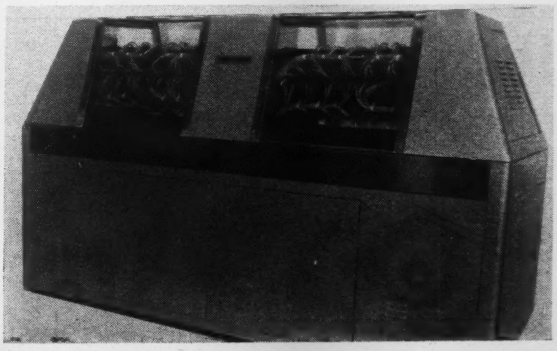
When space is sold, one operation on the Agent's Keyset subtracts the number of seats sold from the inventory count, which is maintained on a magnetic drum. When the inventory on any flight reaches zero, the computer circuits in the master control unit cause a printed record to be made. When the agent presses a "sell" button on his keyset, seats for the chosen flight are taken out of inventory. The agent can also return seats to inventory in event of a cancellation.

By using redundant circuitry (two systems check each other) the Reservisor system has operated with 100% accuracy and less than 0.2% downtime since 1952. The system not only minimizes customer waiting time but also permits merchandising of alternate but equal accomodations and accelerates sale of cancelled space.

Fig. 5 shows the console which contains the magnetic storage drums; Fig. 6 is a closeup of the horizontal drums, showing the read-record heads.

The success of the original system is indicated by the fact that Teleregister is now installing a similar system for American, with a capacity of 2000 flight legs per day for a full month—about 6 times the capacity of the first system. Other airlines have installed similar Magnetronic

Fig. 5. Console containing the Reservisor system magnetic storage drums. Data are recorded in binary form using a polarized (plus or minus) area for each bit.



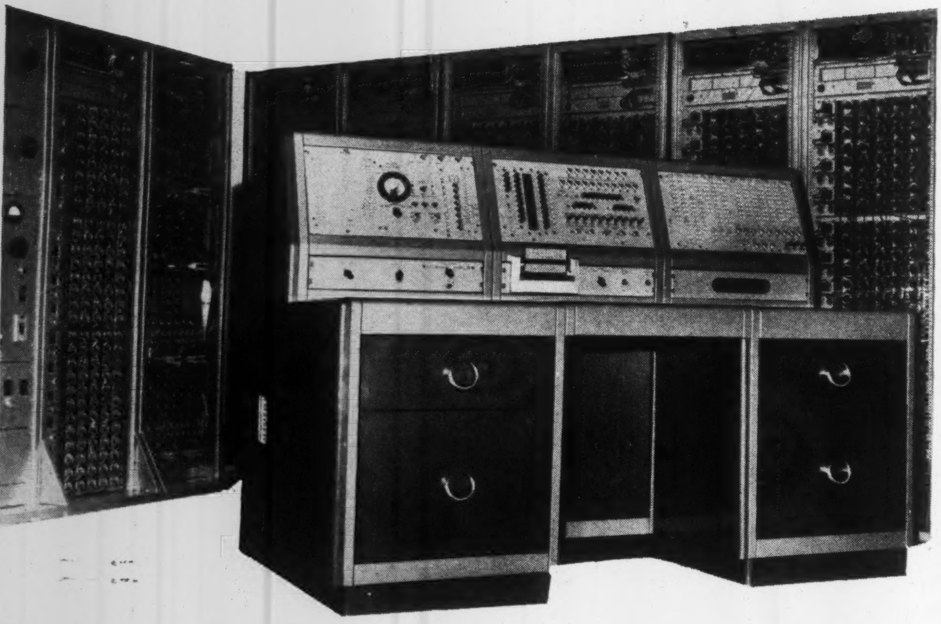


Fig. 7. Desk-like control console permits over-all surveillance of Magnetronic Reservisor system by one supervisor. In background are racks containing electronic circuits of the central computer.

Reservisor systems. Of course, each customer has unique problems. For example, the system installed for Braniff International Airways makes use of the airline's existing communication network; the UNISEL system installed for United Air Lines does not use a magnetic storage drum for exact seat count at present—but permits addition of this feature if desired.

Railroad Reservations

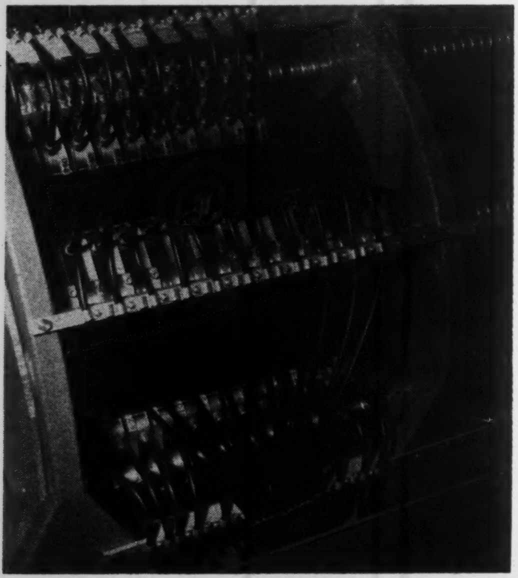
Railroads have similar reservation problems—but of much larger magnitude.

The New Haven Railroad was the first railroad to use such a Magnetronic Reservisor system. Their system can handle up to 1000 reservations per hour; approximately 100,000 individual space accommodations are stored on magnetic drums, accommodating a 31-day period. If a passenger does not pick up his space by midnight of the last date specified, the computer automatically releases the space and makes it available to others.

Time sharing of the vast communications networks between several railroads has been used to effect savings by joint use of data processors, input devices and storage elements, and joint maintenance. For example, cooperation by the New Haven, the New York Central and the Santa Fe railroads has led to a Magnetronic Reservisor system in which about one million individual spaces will be stored in memory, randomly available so that any agent of any of these lines can look up any space, sell the space, and erase it from memory. Space storage will be up to 7 months in advance date.

The railroads inform us that 25,000 reservation look-ups per day will more than pay for the system—without regard to the savings of time on the part of both agent and passenger, nor of the increased accuracy of the system. In addition, extension of the system to the solution of the problems of automatic ticketing and freight-car location (developments now underway) will completely change the economic picture for the railroads.

Fig. 6. Closeup of a horizontal magnetic data storage drum. Wires lead to read-record heads.



Automatic Warehousing

An automatic warehousing system has been developed by Walter Kidde Constructors, Link-Belt Company, and Teleregister. In this system an overhead conveyor with hanging trays moves through the storage area. Each stock picker in the storage areas selects the same items repeatedly for all the different orders, each represented by a punched card which is placed on the tray with the order.

Upon leaving the storage area the tray passes a dispatcher, who removes the card and inserts it in a card reader. Destination data on the card cause the tray to automatically discharge its load on the proper shipping bay. Savings are effected because each stock picker serves only a small area and because distribution to the proper bay is automatic once the card is read.

Automatic Inventory Control

Fig. 8 shows the Magnetronic inventory control system designed for the B. F. Goodrich Footwear and Flooring

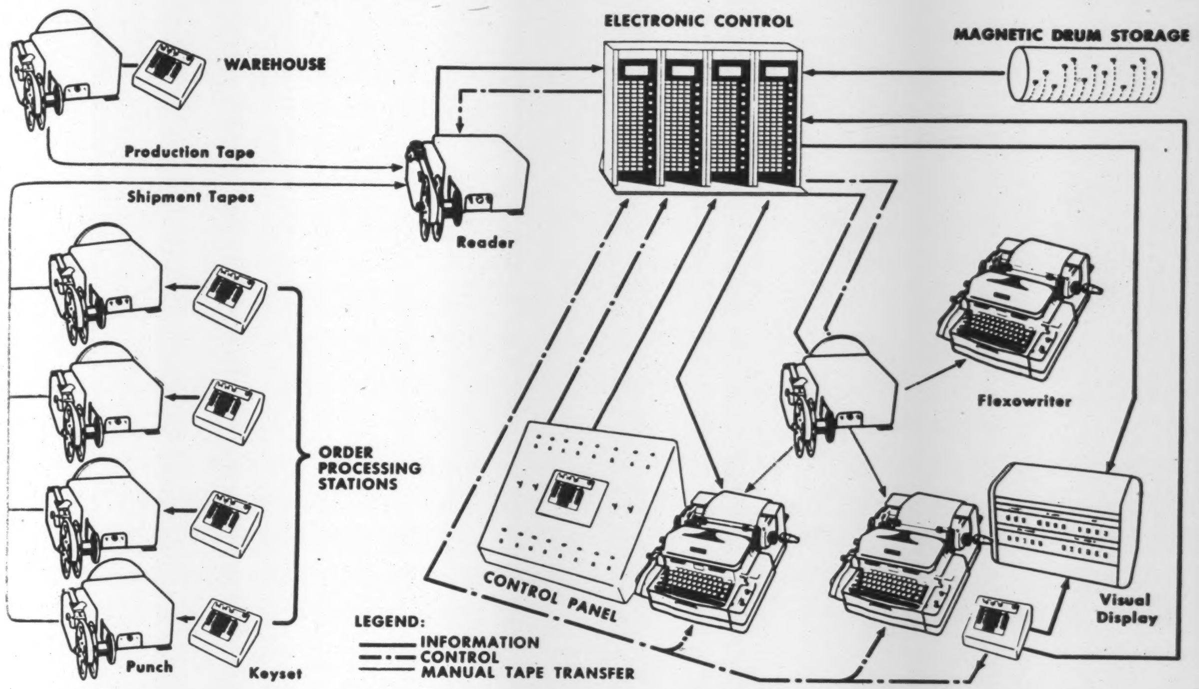

ELECTRONIC CONTROL
MAGNETIC DRUM STORAGE
WAREHOUSE
Production Tape
Shipment Tapes
Reader
Flexowriter
ORDER PROCESSING STATIONS
CONTROL PANEL
Visual Display
Punch
Keyset
LEGEND:
INFORMATION
CONTROL
MANUAL TAPE TRANSFER

Fig. 8. Goodrich plant Magnetronic inventory control system monitors 30,000 style-size-number footwear combinations.

Plant, Watertown, Mass. The system uses many of the components and principles of the Magnetronic Reservisor system, and permits instantaneous determination of more than 30,000 style-size-number combinations of items in inventory and on order.

Clerks record quantities added to inventory by using a small key. The complete inventory or any portion of it can be printed out upon request, or the status of all sizes of one style can be displayed by indicators on a panel. The system can keep track of any item, of any type of item, of prices, etc. The output information can be made available at any remote location.

Automatic Banking

Teleregister has contracted with 3 major savings banks to provide systems which will automate many of the functions now performed manually by tellers.

A typical Magnetronic savings account system is shown in Fig. 9. Tellers at either the main office or any branch are provided with keyset units that are tied into the data processing unit via a distributor. Each branch office requires only a standard Teletype circuit (pair) for communication with the central equipment.

By entering the account number, the teller ommands the central equipment to display he current balance of the account on his keyet. Deposits, withdrawals, interest postings nd other conditions then can be processed utomatically. The passbook is automatically pdated and each transaction recorded in the entral equipment. Drums and tapes are used o store the required data; the desired acount data are taken from the tape and reorded on the drum when a transaction is nitiated; the account is returned to tape storage at the end of the transaction.

During banking hours the system is used exclusively to process deposit transactions. During non-banking hours and at night the system automatically computes interest, processes mortgages, etc.

The Union Dime Savings Bank in New York City will be one of the first banks in the country to use such an automation system for its banking functions.

Conclusion

The examples discussed show how Magnetronic data processing equipment, which is essentially special-purpose digital data handling and computing equipment, is solving basic industrial and economic problems.

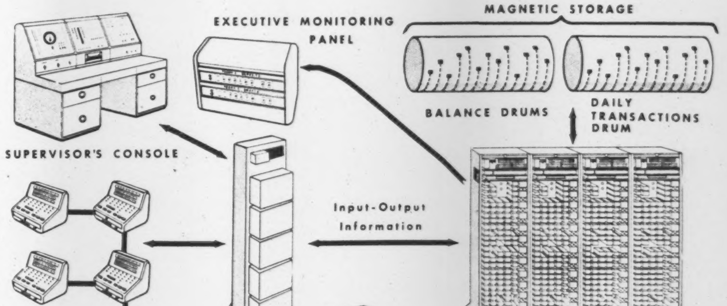

EXECUTIVE MONITORING PANEL
MAGNETIC STORAGE
BALANCE DRUMS
DAILY TRANSACTIONS DRUM
SUPERVISOR'S CONSOLE
Input-Output Information
DISTRIBUTOR
ELECTRONIC DATA PROCESSING UNIT
MAGNETIC TAPE HANDLERS
Tape Up-Dating
Printed Reports
FLEXOWRITER

Fig. 9. Magnetronic savings account system.

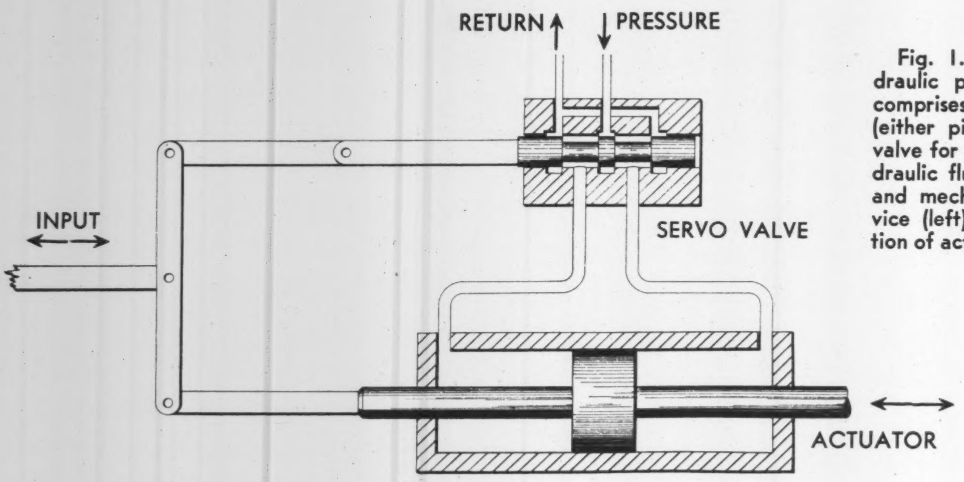


Fig. 1. Basic mechanical-hydraulic position-control system comprises hydraulic actuator (either piston or motor), servo valve for controlling flow of hydraulic fluid to the actuator, and mechanical linkage or device (left) for comparing position of actuator and servo valve

Electrohydraulic Position Control

Comparison of the elements, functions, flexibility, and performance of electrohydraulic servo positioners with mechanical-hydraulic systems shows the relative advantages and disadvantages of each.

L. H. GEYER
Moog Valve Co., Inc.

ELECTROHYDRAULIC position control for high accuracy and high speed of response is a relative newcomer to the family of industrial control systems. Therefore, comparison of the basic advantages and limitations with more established counterparts is in order, particularly with respect to mechanical-hydraulic systems (the electrohydraulic system is in many ways an extension and refinement of the mechanical-hydraulic).

Recent developments are making electrohydraulic control more widely applicable. These developments include: (1) improved electrical computing and data-storage equipment, (2) improved electrohydraulic servo valves, (3) improved electrical position indicating instruments, (4) the economic urge toward increased labor productivity, and (5) new system requirements not readily fulfilled by mechanical-hydraulic systems, nor by conventional electrical motor position controls.

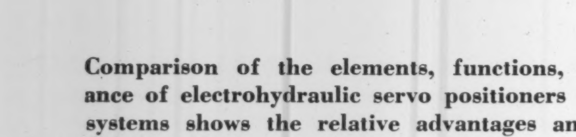


Fig. 2. Block diagram of mechanical-hydraulic system shown in Fig. 1.

The Mechanical-Hydraulic System

The mechanical-hydraulic position-control system is shown in Fig. 1; its equivalent block diagram in Fig. 2. The output load member is driven to its controlled position by means of a hydraulic actuator. This actuator is usually either a rotary hydraulic motor driving the output load through a suitable gearing system, or a piston driving the output load directly or through a linkage. The piston-type actuator is shown in Fig. 1. The velocity of the actuator is directly proportional to the flow to and from the actuator. This flow is controlled by a servo valve. For high-performance systems a closed-center valve is generally appropriate. The final element of this control is a mechanical system for comparison of the *actual* position of the output member and the *commanded* position; this mechanical system opens the servo valve an amount proportional to the difference or error between

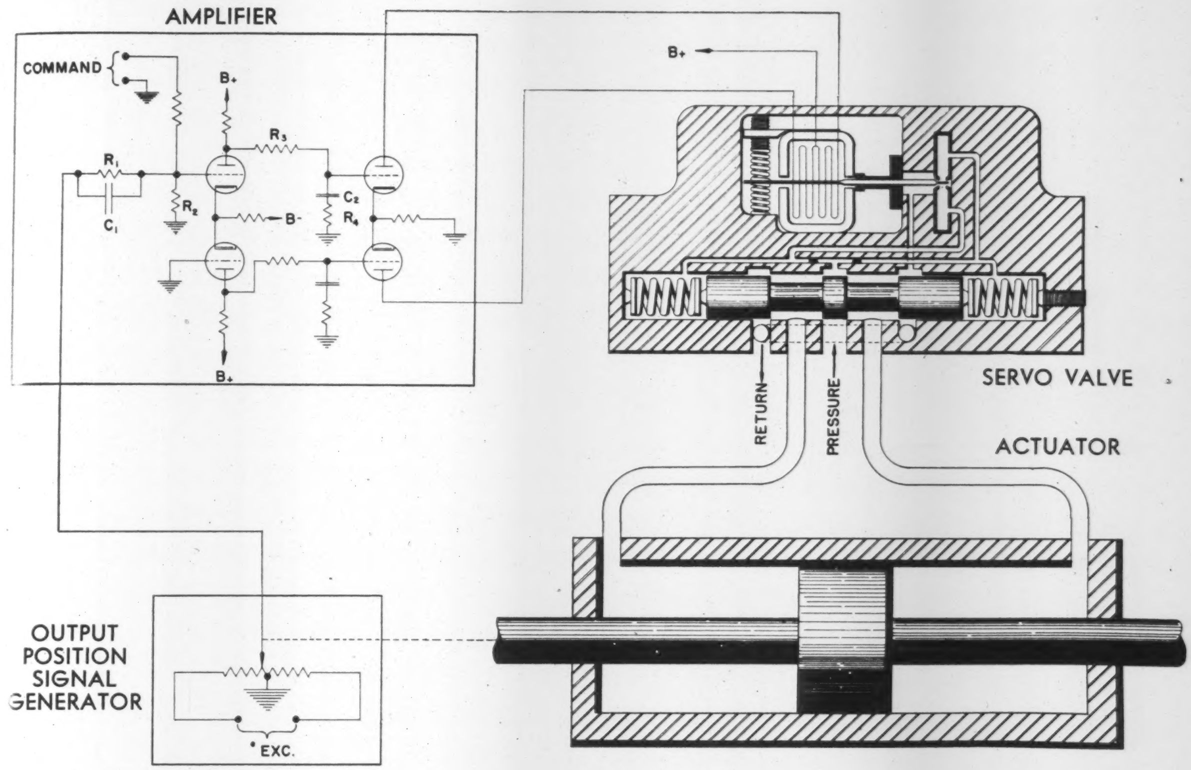


Fig. 3. Electrohydraulic system comprises actuator, electrohydraulic servo valve, and error amplifier. Amplifier network R_3-R_4-C_2 is lag network to reduce velocity error. Network R_1-R_2-C_1 is lead network for rate response.

the actual and the commanded positions. This is done by the input linkage in Fig. 1.

The Electrohydraulic System

The electrohydraulic system (Figs. 3 and 4) is identical to the mechanical-hydraulic system in the actuator section. However, the error signal is determined by electrical measurement of the output position and comparison of this signal with an electrical command signal.

The electrical command signal can be obtained by a similar instrument positioned by a mechanical input template. Alternatively, the input signal can be derived from information stored on tape; the stored information can be digital in nature. The difference between command and actual output signals, or error, can be amplified for increased sensitivity.

Compensating network functions for improved performance can be introduced in the servo amplifier. The amplifier output is applied to the electro-input servo valve, which produces a valve opening proportional to this signal (just as the mechanical valve was opened directly by the mechanical error detector). Although the schematic amplifier of Fig. 3 uses vacuum tubes, amplification can be performed by transistors or saturable reactors.

Comparison of Figs. 1 and 2 with Figs. 3 and 4 shows that the significant differences between these systems is in the method of measuring the error and positioning the valve as a function of that error.

Comparison of Mechanical-Hydraulic and Electrohydraulic Systems

Modern electro-servo valve technology has reduced the lag or delay in establishing valve position as a function of error signal to an equivalent time constant of less than 2 milliseconds (0.002 second). This value frequently compares favorably with the delay function of mechan-

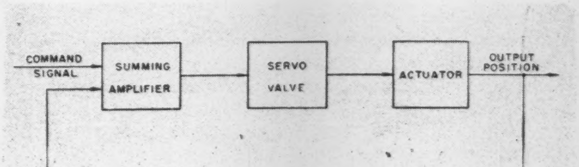


Fig. 4. Block diagram of electrohydraulic system of Fig. 3.

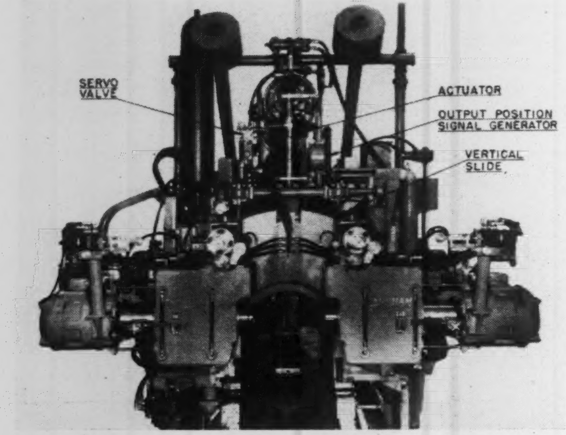


Fig. 5. Example of electrohydraulic tracer control on a spar milling machine.

ical-input valve mechanisms. In any event, this lag is usually negligible compared with other lags in the control loop. Therefore, the mechanical input and the electroinput valves can be considered equivalent as far as component dynamic considerations are concerned.

High-frequency variable-reluctance pickoffs or continuous-composition-element potentiometers can measure the position of the output member with resolutions in the order of 50 microinches (0.00005 inch) or better and with dynamic lags of 0.0002 second or less.

Force loads on the measured member can be reduced to a few ounces or less. The only requirement is to maintain the transducer element, weighing a small fraction of a pound, in contact with the measured surface.

Where reduction of velocity error is important, an integrating (lag) network can be incorporated in the amplifier as indicated by interstage network R_3, R_4, and C_2 in Fig. 3. Where reduction of transient errors in the presence of rapid input variations is important, a derivative (anticipation or lead) network can be incorporated as indicated by input network R_1, R_2, and C_1 in Fig. 3. Where smooth following of small inputs is important, system threshold can be improved by a *dither signal* introduced in the amplifier from a suitable oscillator. Frequently, 60-cycle line frequency introduced through a step-down transformer is a highly satisfactory dither signal. The servo amplifier permits convenient adjustment in controller sensitivity (gain) to achieve optimum performance and stability.

Once position sensing is accomplished by electrical instruments, the conveying of the measured value to a remote point is simple; only wires are required rather than rigid links, chains, or torsion rods. Also, there is no loss in performance and accuracy such as may be introduced by linkage compliance, bearing tolerance, and gear or chain backlash. Once input and output are measured electrically, the incorporation of auxiliary control modes becomes extremely simple. Manual control of output velocity is accomplished by switching from a command-minus-feedback-signal input (to the amplifier) to a manual potentiometer input. Switching to a fixed-reference-voltage input drives the output to a fixed reference position for possible production of parts with constant coordinates, and permits elimination of the command member.

Simple resistor-capacitor input networks can be arranged for switching to fixed output feed speeds, again eliminating the variable-profile command member when linear variation of the output coordinates is needed.

In summary, the new elements of flexibility and possible performance advantages introduced by use of an electrohydraulic system are:

1. Reduction of instrumentation loads on input and output members.
2. Reduction of velocity error through integrating network.
3. Reduction of transient error through derivative network.
4. Reduction of threshold limit by dither.
5. Increased design flexibility through elimination of mechanical linkages.
6. Improvement in accuracy and resolution due to elimination of backlash and compliance of mechanical feedback system.
7. Increased flexibility of servo sensitivity through facility of adjustment of servo amplifier.
8. Increased ease of incorporating auxiliary modes of input through simple electrical signals applied to the amplifier.

The price that must be paid for these advantages is directly related to increased degree of flexibility and complexity introduced. This price is exacted in three general areas. First, a greater cost of initial system design and development may be introduced. Second, the electrical equipment may raise the total cost of hardware over that for a mechanical-hydraulic control. Third, adequate maintenance for the system must be provided.

Applications

Applications for electrohydraulic servo systems are where the total costs of the installation and/or the overriding importance of high performance make the somewhat higher initial costs of the control system economically justified. Examples are large machine tools, test cell installations for engines, transfer and work positioning installations for precise control and high volume production, and positioning of large valves for continuous process industries.

A typical example of an application where electrohydraulics proved itself attractive is a positional "tracer" control for a spar milling machine manufactured by Farnham Division of Wiesner-Rapp Corporation (Fig. 5). This machine features horizontal, vertical, and twist or angular control of each of several cutting heads traveling on one or more carriages along a milling bed up to 104 feet in length. The command templates were secured to the bed.

The weight of the vertically controlled milling head and cutter plus slide mechanism is approximately 8,000 lb. Reasonable limitations on size of structure, etc. result in a mechanical natural frequency in the order of 6 to 8 cps. Design considerations precluded direct mechanical linkage on the vertical control. Accuracy and performance requirements made a mechanical-hydraulic servo marginal even with relatively ideal feedback linkage design. Also, higher cutting speeds were possible with an electrohydraulic system, which was chosen for the application. Similar potential advantages exist for electrohydraulic positioners for control valves in the process industries.

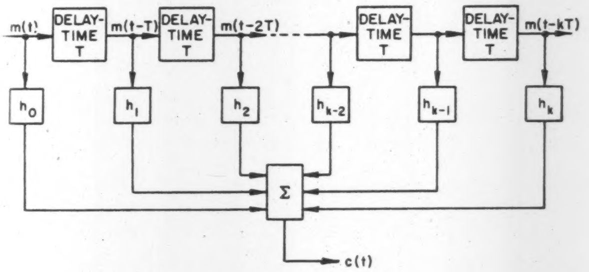
Further cross-fertilization of ideas and problems in the industrial control field will lead to an ever widening circle of applications, as shown by this comparison of basic performance features of electrohydraulic systems with more established systems.

Dynamic Response

The following important papers were presented at the ASME Instruments & Regulators Division Conference, Princeton, N. J., March 26-27, 1956. Copies are available from the American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y. until Jan. 1, 1957. Price: 50 cents per copy; 25 cents to ASME members.

1. **Determination of the Characteristics of Multi-Input and Nonlinear Systems from Normal Operating Records,** by T. P. Goodman (MIT). Paper 56—IRD—17.

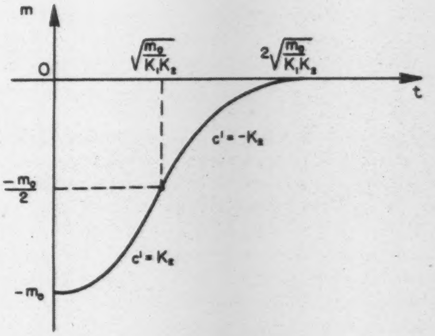
A method is presented for discovering, from the random variations in normal operating records, the impulse responses, or weighting functions, relating an output of a system to two or more inputs that are mutually correlated. This method makes use of the statistical autocorrelation and cross-correlation functions of the system inputs and outputs. From these correlation functions, the weighting functions are obtained by a process of deconvolution by means of an electronic delay-line synthesizer. The method is described first for linear systems and is then applied to nonlinear systems. It is an extension of a method presented in an earlier paper for discovering the weighting function of a linear system with one input.



Block diagram of a delay-line synthesizer (DLS), a tapped electronic delay line device for obtaining a system's impulse response (weighting function) by deconvolution.

2. **Optimum Nonlinear Control,** by R. Oldenburger (Woodward Governor Co.). Paper 56—IRD—13.

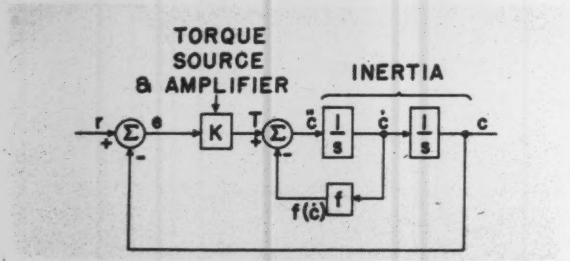
This paper is concerned with the response of a controlled system after an initiating disturbance has died out. Such a transient is obtained, for example, when the load on a prime mover is suddenly rejected or the speed setting of an engine governor is instantly switched to a new value. It is assumed that the rate of change of the controlling variable with respect to time is bounded, and that the maximum rate of change can be obtained arbitrarily. Thus the speed of a hydraulic governor servo is limited. The best return to equilibrium (minimum over or underswing, minimum duration of the transient, etc.) can be obtained under rather general conditions by having the servo or its equivalent travel only at maximum or zero speed. Control functions exist which give the optimum transients. These functions are nonlinear. The results of theoretical studies to enable the control designer to obtain optimum or nearly optimum transients are given here along with practical compromises. All results have been verified in the laboratory with physical devices (governors) of various kinds and automatically controlled systems.



Optimum transient for instant change in setting of controlled variable has no overswing or underswing. There is a unique transient such that all criteria of automatic control theory for optimum transients are satisfied simultaneously.

3. **Physical and Mathematical Mechanisms of Instability in Nonlinear Automatic Control Systems,** by R. E. Kalman (Columbia Univ.). Paper 56—IRD—16.

This paper is a critical examination of the stability problem in automatic control systems containing nonlinear elements. An attempt is made to classify and isolate essentially different phenomena, and to illustrate each type by means of simplified but representative examples. Particular attention is paid to the effects of sys-



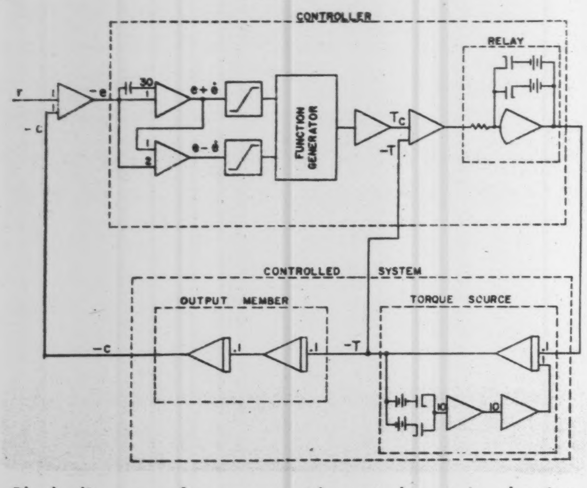
Positional servomechanism in which output element possesses inertia and is subject to combined Coulomb and viscous friction.

tem parameters and system inputs in provoking or destroying instability. The phenomena discussed are so diverse that they defy any over-all conclusions. Still, it is hoped that the classification adopted here will be of help in recognizing important and unimportant aspects of problems in nonlinear control-system design.

4. Design and Analog Computer Analysis of an Optimum Third-Order Nonlinear Servomechanism,

by H. G. Doll and T. M. Stout (Schlumberger Inst. Co.). Paper 56—IRD—10.

Much interest has been shown recently in deliberately nonlinear control systems, including a class of programmed control systems. The design objective which



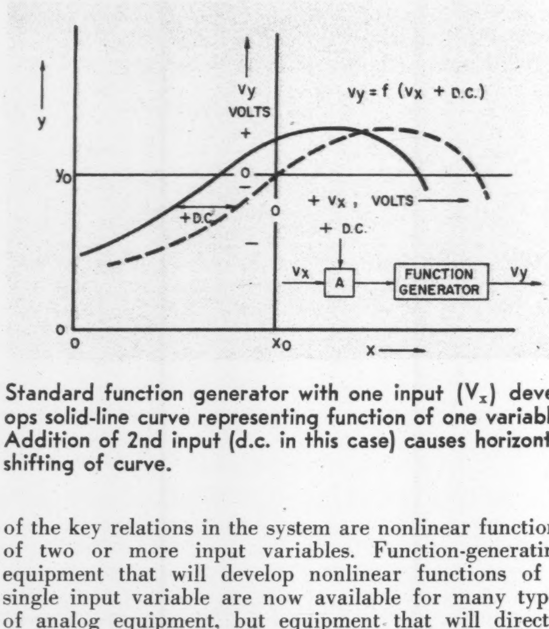
Block diagram of programmed control system, showing two-variable function generator whose output is the torque (computed from equation) which must exist for each combination of e and ė on an optimum trajectory.

distinguishes these systems is minimization of the response time for step inputs by proper automatic timing of relay operations. For a second-order relay servomechanism, the required switching relation is expressed by a curve in a two-dimensional phase plane which can be realized by a one-variable function generator in combination with linear elements. For a third-order system, the switching relation is expressed by a surface in a three-dimensional phase space and requires a two-variable function generator for its realization (see illustration). The switching surface is computed in this paper for an idealized third-order positioning servomechanism having an output member characterized completely by its moment of inertia and a torque which varies linearly with time between two limits; small-signal nonlinearities such as backlash or relay threshold are neglected. An electro-optical two-variable function generator is employed in an analog computer study of this system. For purpose of comparison, two alternative models of control are also examined. The system using programmed control shows the expected superiority for step inputs, the advantage being greatest for small step magnitudes. For sinusoidal or random inputs, programmed control is superior when the input amplitude and/or frequency are low but exhibits some anomalous behavior for large amplitudes and/or frequencies, which result in inferior performance. Parameter tolerances for programmed control systems are somewhat less severe than anticipated.

5. Representation of Nonlinear Functions of Two Input Variables on Analog Equipment,

by D. A. Elliott (Curtiss-Wright Corp., Propeller Div.). Paper 56—IRD—11.

When an analog operator who has been solving problems on a linearized basis begins to employ nonlinear components to represent a wide range of operation of the simulated system, it soon becomes apparent that many

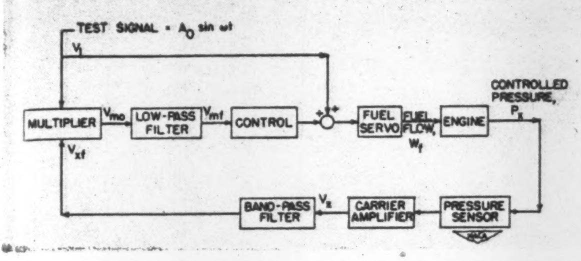


Standard function generator with one input (V_x) develops solid-line curve representing function of one variable. Addition of 2nd input (d.c. in this case) causes horizontal shifting of curve.

of the key relations in the system are nonlinear functions of two or more input variables. Function-generating equipment that will develop nonlinear functions of a single input variable are now available for many types of analog equipment, but equipment that will directly generate three-dimensional families of curves as arbitrary nonlinear functions of two input variables exist only in a few cases of highly expensive specialized equipment. Some methods also have been described for developing three-dimensional curves by reworking standard function-generating equipment to perform the additional mathematical operations required by a second input variable.

6. Experiments with Optimalizing Controls Applied to Rapid Control of Engine Pressures with High-Amplitude Noise Signals,

by G. Vasu (National Advisory Committee for Aeronautics). Paper 56—IRD—14.

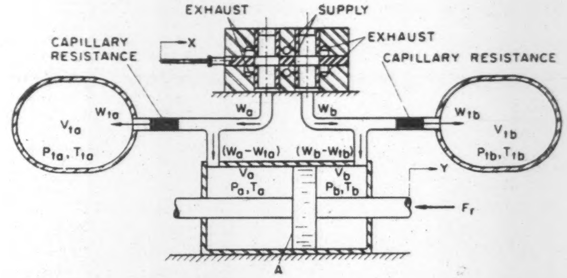

TEST SIGNAL = $A_0 \sin \omega t$
V_i
MULTIPLIER
V_{mo}
LOW-PASS FILTER
V_{mf}
CONTROL
+
+
FUEL SERVO
FUEL FLOW, W_f
ENGINE
CONTROLLED PRESSURE, P_x
V_{xf}
BAND-PASS FILTER
V_x
CARRIER AMPLIFIER
PRESSURE SENSOR

Block diagram of optimalizer control. A sinusoidal signal was introduced (at the fuel servo input). The "control" block causes the fuel servo to seek the peak on a curve of pressure vs fuel flow, which is an optimum operating point.

Optimalizer control principles were applied to the control of a flight-propulsion system. The control system described metered the fuel flow to an engine in such a manner as to cause the engine to seek a maximum pressure. Experimental data are presented illustrating the control behavior for a range of flight conditions, for various control settings such as gain and integral time constant, for various amounts of filtering, and so on.

7. **Nonlinear Analog Study of a High-Pressure Pneumatic Servomechanism,** by J. L. Shearer (MIT). Paper 56—IRD—1.

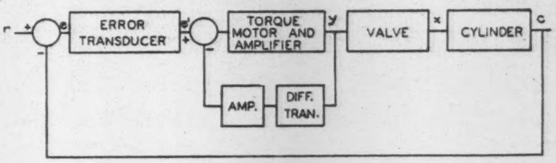
A detailed analog simulation was made in order to evaluate the effects of nonlinear valve characteristics, nonlinear ram-chamber compliance, and coulomb friction in the ram on the dynamic performance of a high-pressure pneumatic servomechanism that has been studied previously with a linearized analysis. This analog study revealed that a major part of the discrepancy between measured frequency-response characteristics and the frequency-response characteristics computed from a linearized analysis is caused by coulomb friction in the ram. Although the system is decidely unsymmetrical when the ram moves near one end of its cylinder, the over-all dynamic characteristics are nearly the same as when the ram moves near its center position. Thus a simple linearized analysis of ram-chamber characteristics, which is possible only when the ram is near its center position, is applicable throughout most of the operating range of the ram. The nonlinear characteristics of the control valve did not seem to be significant in the problem because large pressure differences across the ram never were required to drive the mass load.


EXHAUST
SUPPLY
CAPILLARY RESISTANCE
X
EXHAUST
CAPILLARY RESISTANCE
W_{ta}
V_{ta}
P_{ta}, T_{ta}
W_a
W_b
W_{tb}
V_{tb}
P_{tb}, T_{tb}
$(W_a - W_{ta})$
$(W_b - W_{tb})$
V_a
P_a, T_a
V_b
P_b, T_b
Y
F_f
A

Schematic diagram showing important variables in pneumatic system.

8. **Electrohydraulic Servomechanism with an Ultrahigh-Frequency Response,** by D. P. Eckman (Case Institute of Technology); C. K. Taft and R. H. Schuman (Warner & Swasey Co.). Paper 56—IRD—8.

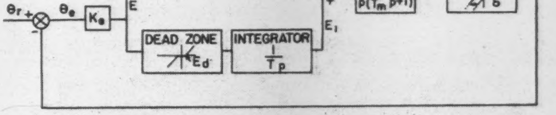
This paper presents an analysis of a positional servomechanism of very high performance. This control employs an electronic error transducer which actuates a pilot valve by means of an amplifier and a torque motor to position a hydraulic cylinder. The control was to have a frequency response whose amplitude ratio was unity (1) to 200 cps at an amplitude of 0.001 in. with 100-lb dry friction and a load mass of 200 lb. These specifications were exceeded by the control described. The optimum open-loop gain and the closed-loop frequency response are determined by linearizing the system equations and using Laplace transform methods. The system also was analyzed by solving the nonlinear equations on an electronic analog computer to determine optimum gain, transient response, and frequency response. A comparison of the results indicates that for input signals which cause the control to operate outside the region in which the linearizing assumption apply, the linear analysis still gives results which agree with those of the nonlinear analysis within a factor of three.


r
+
−
e
ERROR TRANSDUCER
e'
+
−
TORQUE MOTOR AND AMPLIFIER
y
VALVE
x
CYLINDER
c
AMP.
DIFF. TRAN.

Block diagram of electrohydraulic servomechanism.

9. **Nonlinear Integral Compensation of a Velocity-Lag Servomechanism with Backlash,** by C. N. Shen, (Thayer School of Engr.); H. A. Miller and N. B. Nichols (Raytheon Mfg. Co.). Paper 56—IRD—3.

When backlash is encountered in a velocity-lag servomechanism, the system may become unstable. The loop-gain limitation imposed is becoming unacceptable with increasing requirements for following steep ramp inputs as in certain machine-tool-control applications. Integral compensation is not applicable since with backlash oscillations result. This paper analyzes an attempt to overcome this difficulty by intentionally incorporating a second nonlinearity, a dead zone in the input to the integrator. Results are given which allow the approximate transient response of certain systems to be obtained quickly and the question of stability is considered. Finally, an example of its application is given along with a discussion of several practical factors involved.


θ_r
+
−
θ_e
K_e
E
DEAD ZONE
E_d
INTEGRATOR
$\frac{1}{T_p}$
E_1
+
+
E_m
MOTOR
$\frac{K_m}{p(T_m p+1)}$
θ_m
BACKLASH
δ
θ_c

The nonlinear system with nonlinear integral control.

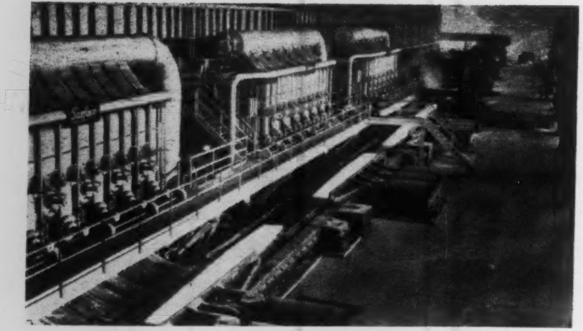


Fig. 1. View from discharge side shows the 3 new slab-heating furnaces at Weirton Steel Co. Furnaces were built by Surface Combustion Corp.

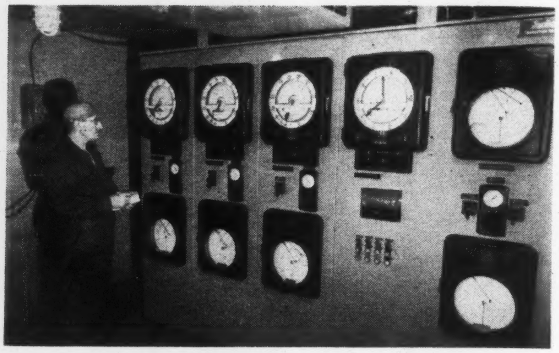


Fig. 2. Control panel for one furnace. Top row (left to right) contains temperature recorder-controllers for each of the 3 zones, the combustion-air temperature recorder-controller, and a 2-point pressure recorder for gas and air. Bottom row contains fuel flow and fuel/air ratio recorder for each zone and (bottom right) furnace pressure recorder.

Combustion Control of

Control of slab heating furnaces includes control of (1) zone temperature, (2) gas pressure, (3) furnace pressure, (4) combustion-air temperature, and (5) fuel/air ratio for each zone.

THREE NEW SLAB FURNACES were included in Weirton's reconstruction program started in 1954, designed to increase production. The furnaces, each with a capacity of 200 tons of slabs per hour, were required to heat the steel for a larger hot strip mill.

The furnaces (Fig. 1) are quadruple-fired, with all the burners firing toward the charging end of the furnace. The furnaces are divided into three zones. The soaking zone is equipped with two sets of burners, the other two zones have one set each. The furnaces are 93′ long, measured inside from the charging door to the discharge slope. The inside width from wall to wall is 28′. Capacity of furnaces is 200 tons of slab per hour per furnace. The maximum slab dimensions are 8″ thick, 26′ long and 50″ wide; maximum slab weight thus is 30,000 lb.

Fuels used are coke-oven gas, mixed gas (natural gas and air), and fuel oil. The fuel rate is approximately 3,500 cu ft of 500-BTU gas per ton of steel. With an average fuel input of approximately 400,000,000 BTU per hour per furnace, and a preheated air temperature of 800 to 1000°F, 300,000 pounds per hour of combustion air and 260,000 pounds per hour of flue gas are required.

Instrumentation on each quadruple-fired furnace consists of 3 temperature recording-controllers (for the three zones of the furnace), controllers for gas pressure, furnace pressure, combustion-air temperature, and fuel/air ratio, all of which are panel mounted. The combustion control equipment is separately housed in boxes in the basement, one for each furnace, containing gas and pressure regulators, hydraulic pumps, reservoirs, valves and gages. Regulator settings are changed pneumatically from the control room.

Control Panel and Fuel Control Housing

Fig. 2 shows the cubicle type control panel for one furnace. Here we record and control zone temperature, gas pressure, furnace pressure, combustion-air temperature, and fuel/air ratio. At upper left are the round-chart *temperature recorders* for the 3 zones, and separately housed *pneumatic control units.* Zone *fuel flow* and *fuel/air* ratio recorders are immediately underneath. The fourth instrument in the upper row is the *combustion-air temperature* recorder-controller. The next instrument (in the right-hand upper corner) is a 2-point *pressure recorder for gas and air.* In the lower right-hand corner is the *furnace pressure recorder.* The manual/automatic switches are also located on the panel. Note the absence of any combustion-control equipment.

Fig. 3 shows the fuel control equipment, which is located in a compact housing in the basement. Combustion control, gas and furnace pressure regulators, hydraulic pumps, reservoirs, valves, gages, etc., for one furnace are

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Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, 1956.

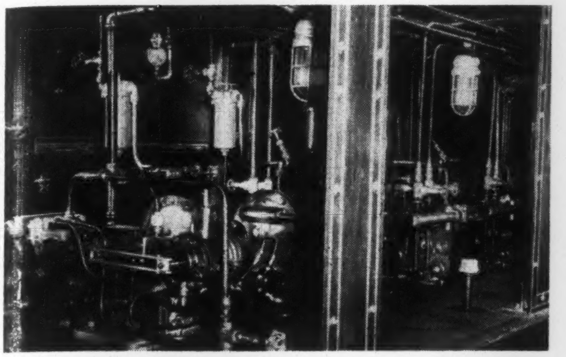


Fig. 3. Fuel control equipment for one furnace includes jet-pipe-type hydraulic fuel/air ratio controller (left), gas and furnace pressure regulators, hydraulic pumps, reservoirs, valves, etc. This equipment is located in the basement.

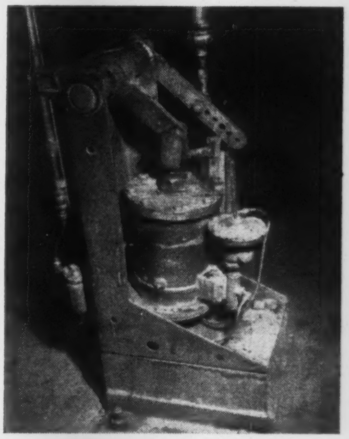


Fig. 4. Hagan receiving regulator, which positions a butterfly valve in a zone combustion-air line.

Slab Furnaces

ROBERT A. FRANCY

Weirton Steel Co.

neatly arranged together. A non-inflammable hydraulic fluid, Pydraul F-9, is used in these systems. Regulator settings are varied by a pneumatic positioner which in turn is positioned by air loading pressure from the panelboard. The regulators are equipped with an Askania "Type B" valve with solenoid operators so that it is possible to open or close the gas valves by turning the manual/automatic switches in the control room.

Temperature Measurement and Control Systems

Temperature in the soak and top zones is measured by "Ray-o-tubes" sighting on a protection tube of silicon carbide with a flat-end fyrestan liner. For the bottom zone the sighting tube is placed in the side wall of the furnace about 10′ away from the burners and 5′ above them. There is a special tile in these locations for the sighting tube. The hole through the tile is recessed on the furnace side so that the effect of the cooler part of the wall is minimized.

The output air from the temperature controller is connected to a "Type BAL" Hagan receiving regulator which in turn positions the butterfly valve in a zone combustion-air line. Fig. 4 shows one of the regulators and the connections. The combustion-air flow is measured by a Pitot tube inserted in the air line. This flow is used to control the fuel flow via a fuel/air ratio positioner.

Air temperature is measured with a thermocouple located just downstream from the combustion-air blower.

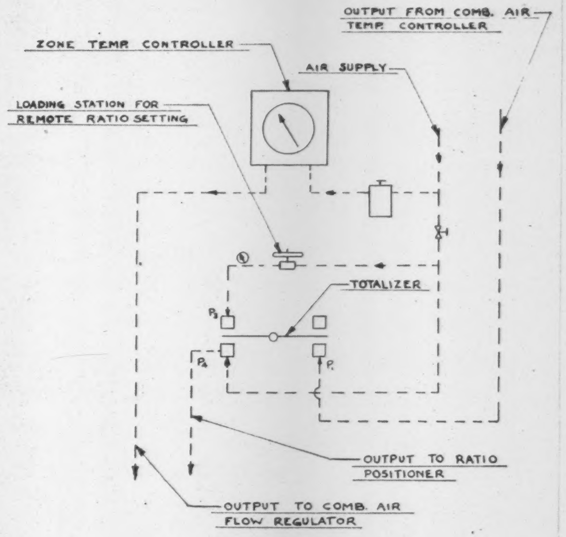

OUTPUT FROM COMB. AIR TEMP. CONTROLLER
ZONE TEMP. CONTROLLER
AIR SUPPLY
LOADING STATION FOR REMOTE RATIO SETTING
TOTALIZER
P_3
P_4
P_1
OUTPUT TO RATIO POSITIONER
OUTPUT TO COMB. AIR FLOW REGULATOR

Fig. 5. Combustion-air flow and fuel/air ratio control system for one zone. Combustion-air flow is controlled by zone temperature controller. Ratio positioner (See Fig. 7) is controlled by a totalizer that is made responsive to combustion-air temperature and remote ratio setter. This totalizer is on panel.

The controller has adjustable proportional band and manual reset. The output of this instrument is used to load a Hagan totalizer and, in turn, a "Type BAL" receiver regulator to position a damper in the cold-air inlet line ahead of the blower.

The fuel/air ratio is also corrected by air temperature. Fig. 5 shows how this correction is made: Air pressure from the Conoflow manual loading station is fed into the #3 chamber of a Hagan totalizer (P_3). This chamber is opposed by a chamber connected to air supply (P_4). Thus any pressure change originating from the manual loader is relayed through the totalizer to the ratio positioner in the basement; this changes the ratio slider on the regulator. Loading pressure from the combustion-air temperature controller is sent into the totalizer at P_1, with the result that the output pressure is now a function of the two input pressures, or $P_4 = P_1 + 1.8P_3$. Thus any air temperature deviation from the standard 700° F set point causes a small change in the ratio set-

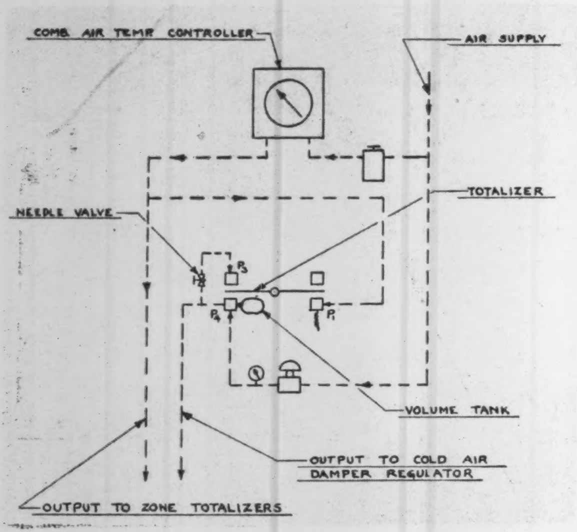

COMB. AIR TEMP. CONTROLLER
AIR SUPPLY
TOTALIZER
NEEDLE VALVE
P3
P4
P1
VOLUME TANK
OUTPUT TO COLD AIR DAMPER REGULATOR
OUTPUT TO ZONE TOTALIZERS

Fig. 6. Cold-air damper is controlled by Hagan totalizer which is made sensitive to changes in combustion-air temperature (chamber P_1). Tank and needle-valve arrangement between P_4 and P_3 produces reset action.

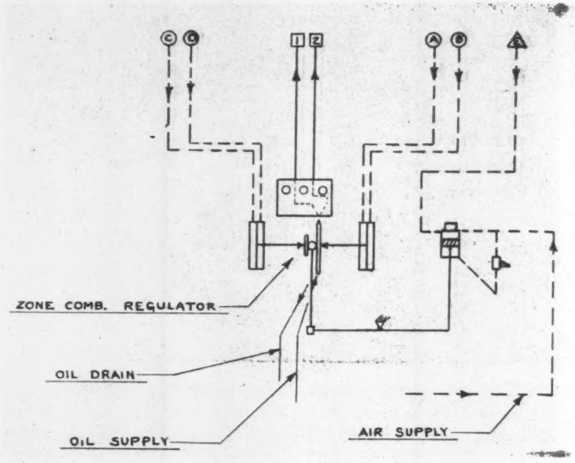


Fig. 7. Zone combustion (fuel/air ratio) regulator is Askania jet-type controller. Signals A and B are combustion-air-flow signals; signals C and D are gas-flow signals. Ratio is set by signal E from totalizer on control panel (shown in Fig. 6).

tings in the various zones to compensate for thinner or denser air.

The action of the totalizer in operating the cold-air damper is shown in Fig. 6. The output signal from the combustion-air temperature controller enters the totalizer at P_1. Air supply is fed into P_4, and a connection is made between P_3 and P_4 via a volume-tank-and-needle-valve arrangement that produces reset action. Spring loading at P_1 allows a shift of the receiving regulator with respect to the original input signal. As it is impossible to adjust the throttling range in the air temperature instrument without upsetting the correction device described, the purpose of the totalizer is to permit a manual reset action without upsetting the former if the controlled temperature deviates too much from the set point.

The control of air temperature is not ideal; it tends to fluctuate due to the lack of automatic reset in the control. However, the correcting action of the totalizers keeps the fuel/air ratio in proportion.

Action of one zone combustion regulator is shown in Fig. 7. As explained previously, the positioner moves the ratio slider as a result of a signal through line E from the totalizer on the control panel. Lines A and B are impulse lines from the metering Venturi in the zone combustion-air line. Lines C and D are loading lines from the orifice in the zone gas line. A demand for more or less heat from the zone temperature recorder-controller repositions the zone air flow control valve. This results in a loading change on the air diaphragm, a repositioning of the jet pipe, and a corresponding hydraulic signal. The signal is transmitted through either line 1 or 2 to a hydraulic cylinder which repositions the zone gas butterfly valve. Thus the amount of gas flow to any zone of the furnaces depends on the amount of air flow to the zone, plus or minus the amount of gas the heater has changed manually on the ratio setter, plus or minus the correction applied by the air-temperature controller due to a change in combustion-air temperature.

A wiring diagram of the gas control is shown in Fig. 8. Power is supplied to the individual zone gas regulators through a holding circuit composed of an interlock on the combustion-air blower, an oil-pressure switch, instrument air pressure switch, a main-line gas-pressure switch, and a holding circuit on the gas relay. Changing the position of the manual/automatic switch energizes the solenoids of the "B" valve to produce the desired action by means of the hydraulic cylinder.

Upon failure of any of the holding circuit components, relay CR-1 drops out, releasing CR1-1 and picking up CR1-3 and -4, which puts power on the zone gas regulator solenoids to drive the zone gas valves closed. Under normal operating condition, the solenoids are de-energized. In event of total power failure, a solenoid valve in the fuel control housing opens, and stored hydraulic power is applied to the main furnace gas valve to drive it closed.

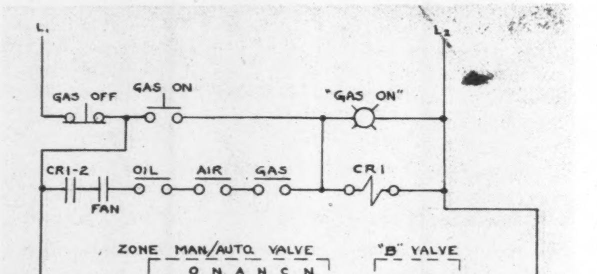
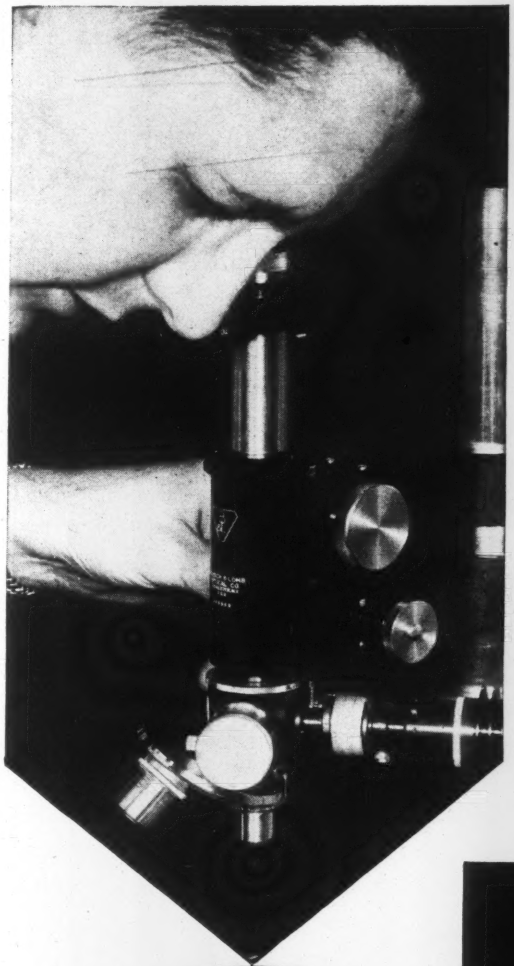


Fig. 8. Gas control wiring diagram with safety interlocks.



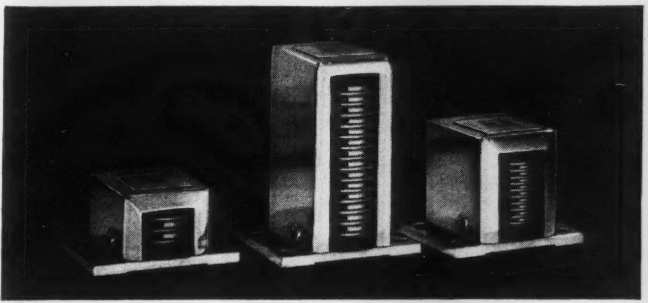
BRUSH *announces...*

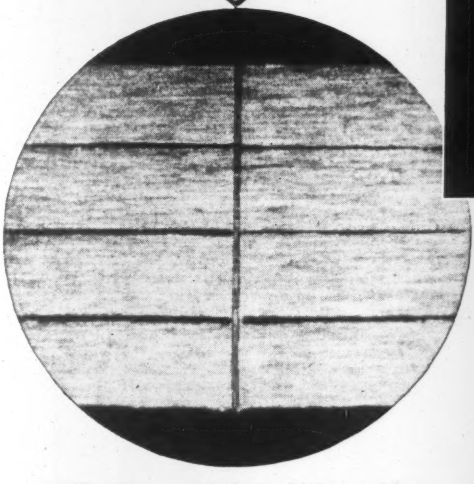
NEW PRECISION MAGNETIC HEADS FOR CRITICAL RECORDING APPLICATIONS

Brush now offers a new design concept in multichannel magnetic heads which provides extremely close tolerances to assure accuracy in recording and reproduction. These heads have already been proven in exacting airborne and missile applications.

ADVANTAGES

- **Uniform output assured by close mechanical tolerances on track width and channel spacing ... ± .002 in. maximum.**
- **Channel-to-channel timing accuracy provided by precise gap alignment... ± .0001 in. maximum.**
- **Crosstalk minimized by full shielding.**
- **Sustained accuracy under severe operating conditions assured by our new construction techniques.**





400X enlargement shows high precision gap and track construction.

AVAILABILITY

Brush offers these heads in three designs: providing 7, 8, or 13 tracks per inch. Heads may be interlaced to provide up to 25 tracks per inch. Modifications or new designs using this construction technique may be made to your requirements. Consult Brush on your magnetic head needs—write Brush Electronics Company, Department A-80, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio
BRUSH ELECTRONICS
DIVISION OF
CLEVITE CORPORATION

For more information circle **61** on inquiry card.

Progress in the Science of Measurement

WESCON SHOW
Booth 237

ELECTRICAL MEASUREMENTS
RECENT RESEARCH IN ELECTRICITY AND MAGNETISM
PAPERS ON ELECTROSTATICS AND MAGNETISM
TREATISES ON ELECTRICITY GALVANISM & MAGNETISM
ELECTRICAL MEASUREMENTS
Honeywell
Doelcam
NULL INDICATOR

Doelcam

MAGNETIK NULL INDICATOR

The Sensitivity of the Galvanometer without any of its Limitations

The Doelcam Magnetik Null Indicator, Model 2HG-1, is both a null balance detector and a linear deflection indicator. It may be used as either a low-level laboratory instrument where accurate null measurement is important, or as a fast measuring production test instrument where linear off-balance readings and ability to withstand rough usage are essential. All around improved performance is achieved by use of the unique Doelcam Second Harmonic Magnetic Converter as the input modulator.

Write for Bulletin NI-4

Doelcam
A DIVISION OF MINNEAPOLIS-HONEYWELL
1400 SOLDIERS FIELD ROAD
BOSTON 35, MASSACHUSETTS

Instruments for Measurement and Control

Synchros • Gyros • Accelerometers • Amplifiers • Microsyns • Servo Motors

PERFORMANCE CHARACTERISTICS

ISOLATED INPUT: Input terminals are isolated from chassis and circuit ground.

HIGH SENSITIVITY: 2 Microvolts per division, 0.003 Microamperes per division.

HIGH CONVERTER FREQUENCY: 2500 cps carrier, insensitive to 60 or 120 cps pickup.

LOW NOISE LEVEL: Less than 2 Microvolts equivalent input.

EXCELLENT STABILITY: Zero drift less than 1 division per hour.

INDEPENDENT OF LINE VOLTAGE: No observable drift or change in sensitivity for line variations from 105 to 125 volts.

PROPORTIONAL DEFLECTIONS: Linearity over full scale range is 5%.

POLARITY SENSITIVE: Zero-center mirror-scale meter for polarity sensing measurements.

QUICK READING: Time constant of less than 1 second.

RUGGED: Not damaged by over-range of 45 volts d-c.

LOW MAINTENANCE: Only one vacuum tube. No moving parts except meter.

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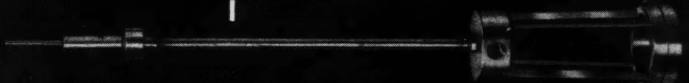
NOW . . . no knife edges to cut performance

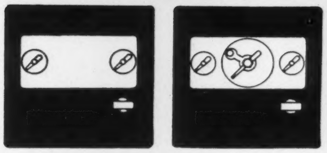
NEW . . . Displacement-Type LIQUID LEVEL CONTROLLER

Nobody thought it could be done: In one sweeping new approach Kieley & Mueller has eliminated the knife edge . . . biggest trouble spot in displacement principle instrumentation.

In place of knife edges which dull in time, the K&M Flexotrol introduces the *torque table*. It's perfectly centered always . . . requires less torque. It's free-turning . . . only 4° required. Yet it doesn't have a single spot for gunk to collect requiring maintenance, affecting accuracy. A torque tube is employed . . . still the controller is actuated by a torque rod that does not twist. Both torque tube and torsion table legs are Inconel-X . . . a special material resisting corrosion and fatigue alike. Five million cycles has shown no detrimental effect.

The full story is in Bulletin 456-1. Send for your copy.





For installation and operating convenience, the *Flexotrol* Controller is reversible and rotatable . . . but something more: optional mechanical indication, independent of the pneumatic system, is your final and positive check. Available with all control features including automatic reset.

KIELEY & MUELLER, INCORPORATED

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64 Genung Street • Middletown, New York
diaphragm control valves and regulators for over 75 years

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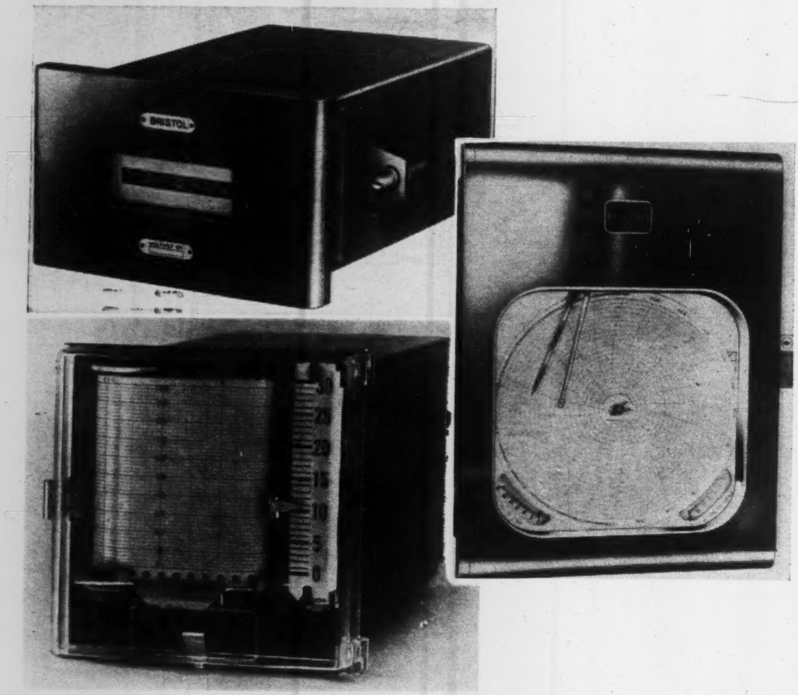
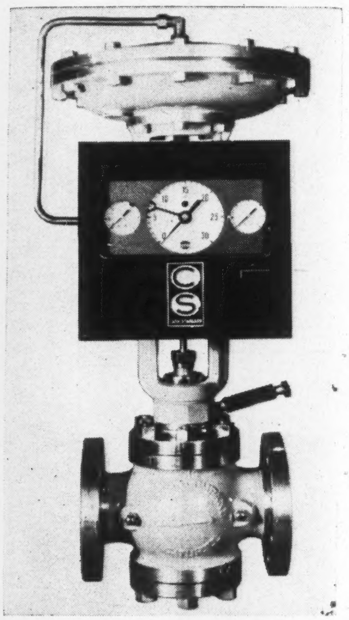
Pic Preview of
11th Annual ISA Exhibition



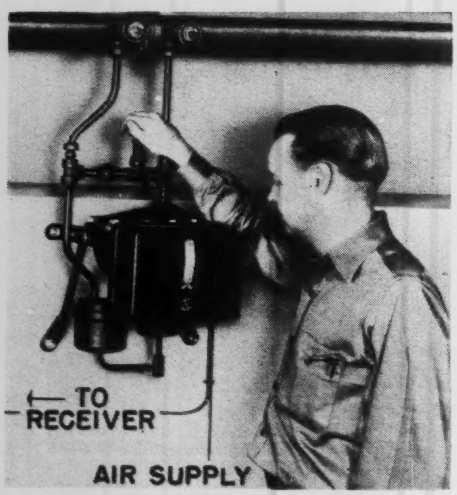
The Bristol Company will announce several new products, including: a new system of telemetering instruments that totalize several flow measurements, correct for temperature, pressure, specific gravity and supercompressibility, and provide a corrected flow value; a remote, integrating, 7-digit counter for use with pneumatic transmission systems; a new high-stability, wide-band pneumatic controller; new high-speed self-balancing recording potentiometers that give full-scale traverse in 0.4 seconds; and a new self-balancing electronic potentiometer that provides a continuous record on a 3" strip-chart.

For more information circle **901** on inquiry card.



A. W. Cash Co. (Cash Standard) will show new valve mounted indicating controller with proportional band and differential gap. Other new products are loading panels, recording controllers, and recorders.

For more information circle **902** on inquiry card.

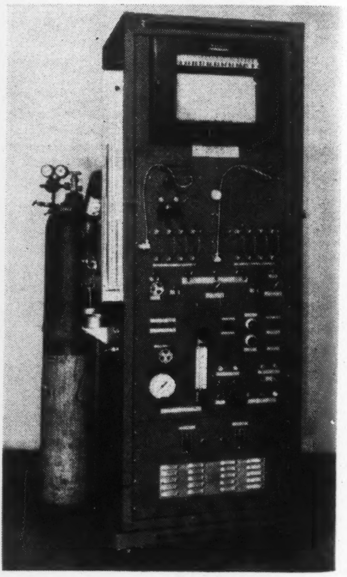


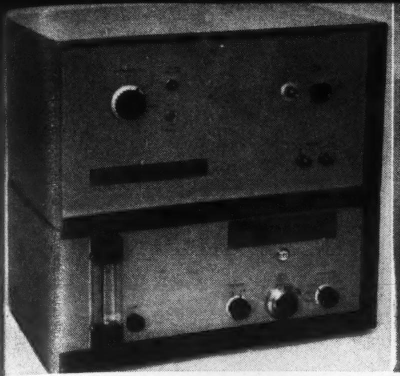
Bailey Meter will display a new differential pressure transmitter that extracts square root and sends out linear signal.

For more information circle **903** on inquiry card.

Hallikainen-Shell Chromagraph for the analysis of gases, liquefied gases and liquids is shown here and will be displayed with other Shell designed instruments such as a temperature controller, a recording viscometer and a vapor-pressure recorder.

For more information circle **904** on inquiry card.





Consolidated Electrodynamics Corp. will introduce their new "Chromatograph" for quantitative and qualitative analysis of gases and volatile liquids.

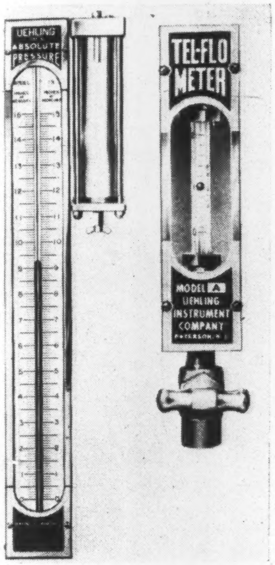
For more information circle **905** on inquiry card.

New, portable, leak detector for evacuated or pressurized systems will also be among CEC products at the show.

For more information circle **905** on inquiry card.

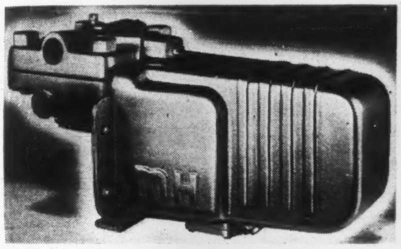
CEC booth will also feature the "Datagraph", a new direct-writing oscillograph that provides instantaneous permanent recordings of frequencies up to 250 cps.

For more information circle **905** on inquiry card.


UEHLING
ABSOLUTE PRESSURE
TEL-FLO METER
MODEL A
UEHLING INSTRUMENT COMPANY
PATERSON, N.J.

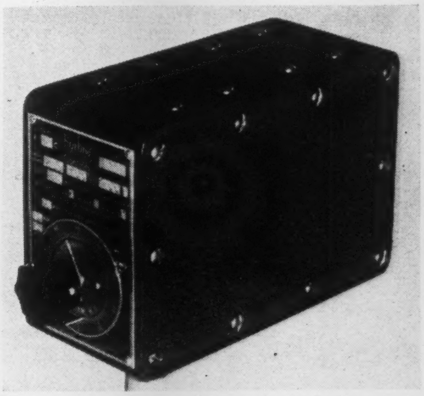
New "Tel-Flo" meter for purging lines, a new mercury vacuum and pressure indicator for ranges up to 100 inches, and a new absolute pressure indicator will be featured by the Uehling Instrument Co.

For more information circle **906** on inquiry card



Minneapolis-Honeywell's Industrial Division will exhibit a new flow-and-liquid-level transmitter for use on 5 to 25 inches of water at static pressures to 200 psi and also introduce small, high-pressure diaphragm control and hand valves.

For more information circle **907** on inquiry card.

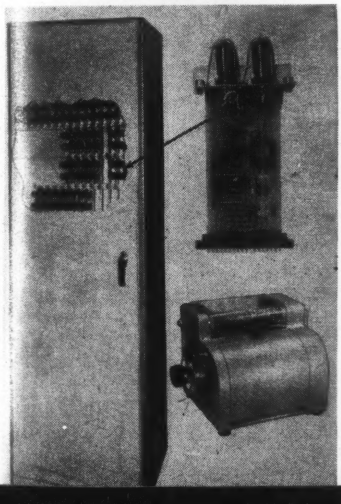


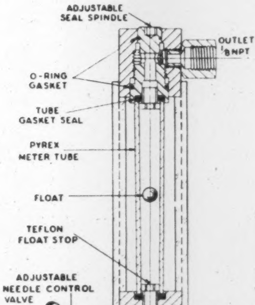
Temperature controllers made by Burling operate by differential expansion of two concentric tubes.

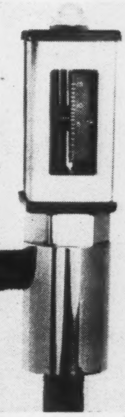
For more information circle **908** on inquiry card.

Radiation, Inc. will show its new ADAR (analog-to-digital-to-analog) recording system.

For more information circle **909** on inquiry card.




ADJUSTABLE SEAL SPINDLE
OUTLET 1/8 NPT
O-RING GASKET
TUBE GASKET SEAL
PYREX METER TUBE
FLOAT
TEFLON FLOAT STOP
ADJUSTABLE NEEDLE CONTROL VALVE
INLET 1/8 NPT

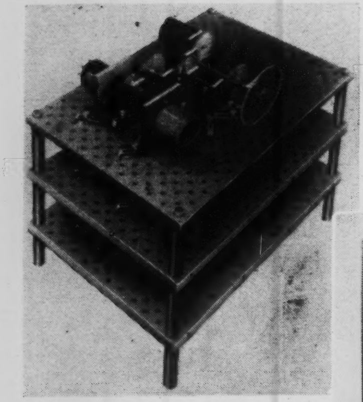


Brooks Rotameter Co. will display the armored flow indicator Model 3602, and the Sho-Rate "50" purge meter.

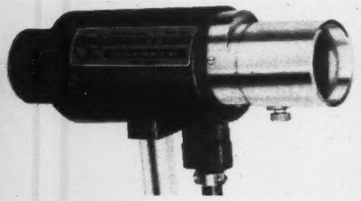
For more information circle **910** on inquiry card.

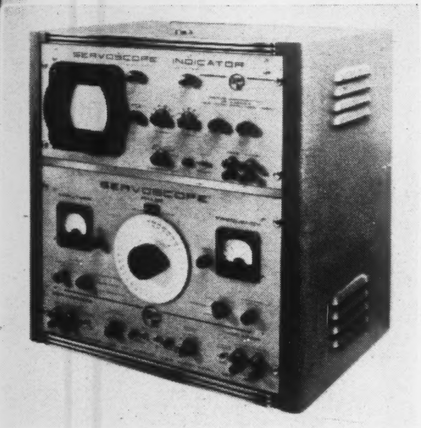
BOSCAR's E, J, and N (ballistic film analyzers and recorders) are Benson-Lehner's featured new products.

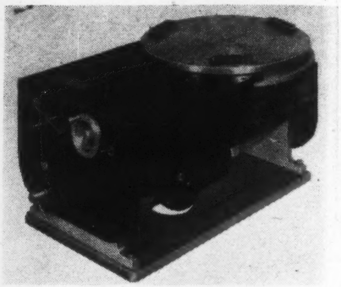
For more information circle **911** on inquiry card.



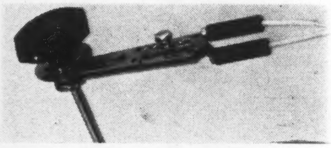
▲Servo Corp. of America will give three products their premiere: (Top) electromechanical assembly kit; (Right) multiple signal generator; and (Top Right) Model IR-2 Servotherm infrared radiation pyrometer.
For more information circle **912** on inquiry card.



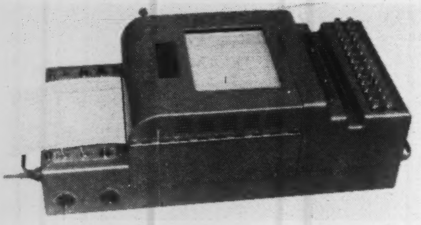




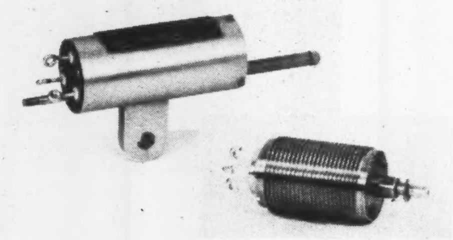
▲Genisco, Inc. will have its new rate-of-turn table (Model 347) for testing rate gyros on exhibit.
For more information circle **913** on inquiry card.



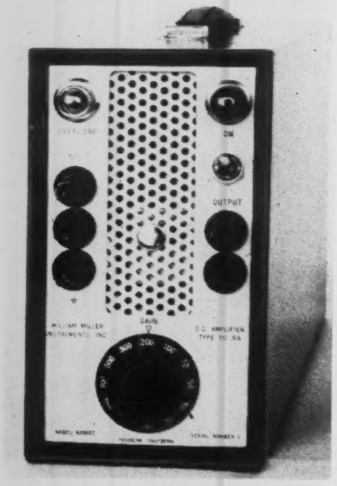
▲Kollmorgen Optical will have a new line of borescopes on exhibit ranging from needle size to large industrial types.
For more information circle **914** on inquiry card.



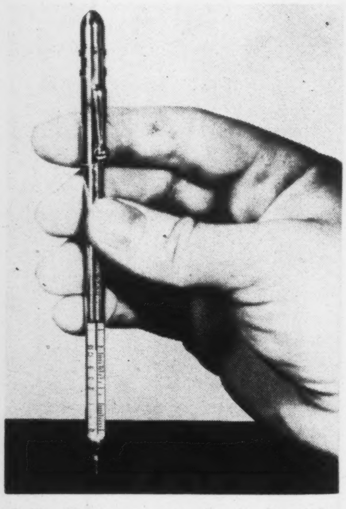
▲Century Electronics & Instruments will display the new Model 420 24-channel electrophotographic recording oscillograph.
For more information circle **915** on inquiry card.



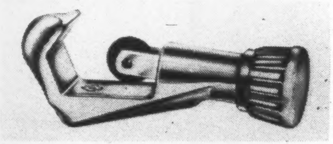
▲Displacement potentiometer Series 2242, interchangeable with dial gage, and subminiature series 2131 are new products of Colvin Labs.
For more information circle **916** on inquiry card.



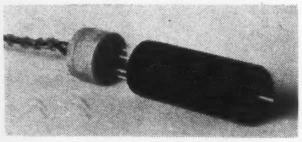
▲William Miller Instruments will display a new dc chopper-stabilized amplifier featuring a 10 step attenuator, current overload indicator and zero adjustment.
For more information circle **917** on inquiry card.



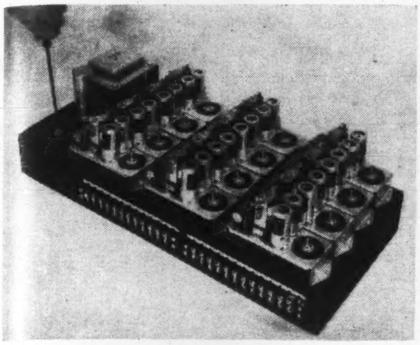
▲The Tinsley gage to be displayed by James G. Biddle Co. measures non-magnetic coatings on ferrous bases.
For more information circle **918** on inquiry card.



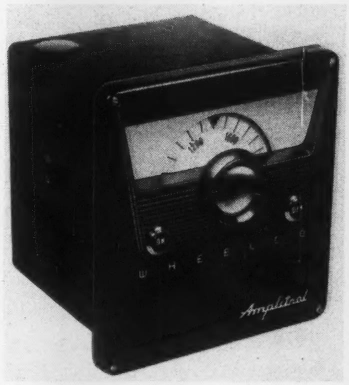
▲Imperial Brass will exhibit a new tube cutter for nylon tubing and a one-to-ten tube rack and bend holder.
For more information circle **919** on inquiry card.



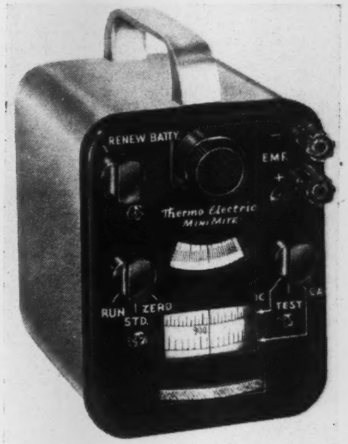
▲Diehl Mfg. Co.'s new induction potentiometer is operable at 70,000 feet altitude without pressurization.
For more information circle **920** on inquiry card.



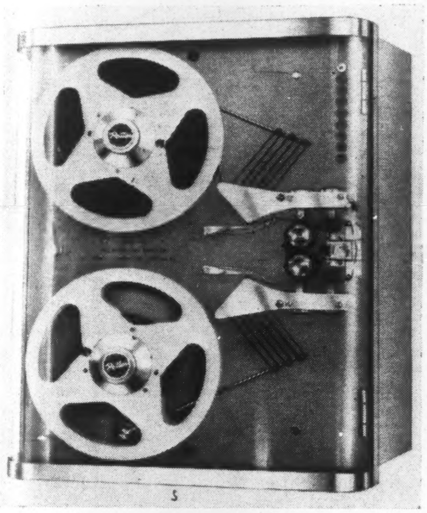
Fenwal's new feature product is the Unit Thermistor Controller-Series 53000.
For more information circle **921** on inquiry card.



Wheelco Div. of Barber-Colman will unveil its new Amplitrol, Series 150 non-indicating potentiometer controller especially suited for batch process work.
For more information circle **922** on inquiry card.

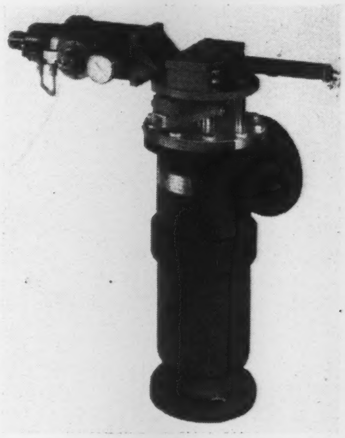


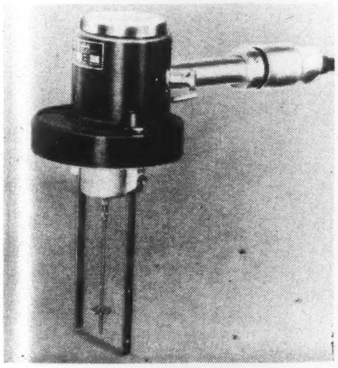
New "MiniMite", portable potentiometer indicator will be shown for the first time by Thermo Electric Co. The four pound instrument has a 23½" scale and is used for direct measurement of temperature, or as a comparison instrument to check other millivoltmeter or potentiometer-type instruments.
For more information circle **923** on inquiry card.



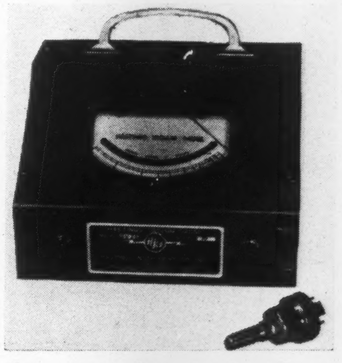
New digital magnetic tape handlers with tape speeds up to 75"/s and 3 millisecond starts and stops will be featured by the Potter Instrument Co.
For more information circle **924** on inquiry card.

W. A. Kates Co. will introduce its new air operator for set point adjustment which permits integration of the Type SA regulator into any 3-15 psig air control system.
For more information circle **925** on inquiry card.

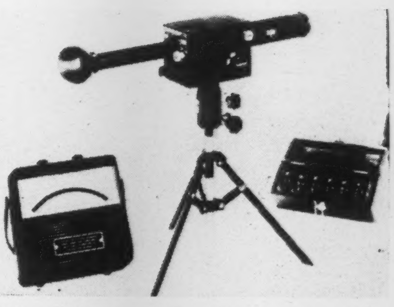




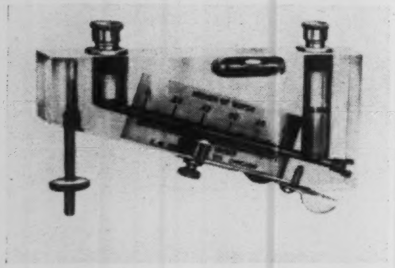
Brookfield Engineering Labs. will display their new explosion proof viscometer designed expressly for Class I, Group D locations in the chemical industry.
For more information circle **926** on inquiry card.



A new single-meter-type vacuum gage, 0-100 microns Hg full scale, is Hastings-Raydist latest development.
For more information circle **927** on inquiry card.

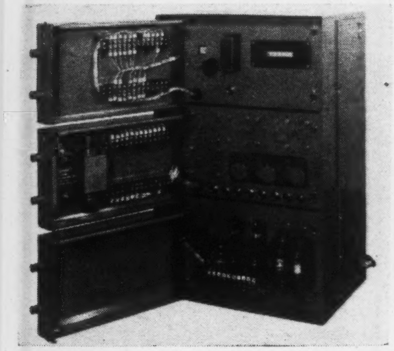


This new pyro micro-optical pyrometer has been designed by Pyrometer Instrument Co. to measure temperatures over 700°C (1300°F) from targets less than 0.001" dia. Its portability allows it to be taken from the lab for general plant applications.
For more information circle **928** on inquiry card.



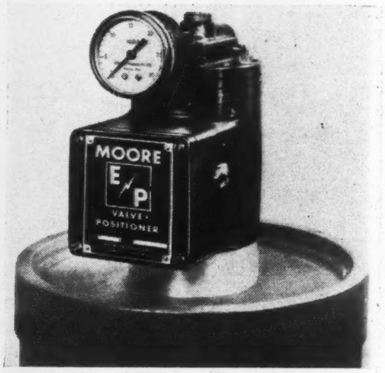
F. W. Dwyer Co. will exhibit their new No. 400 Meter which measures air velocity and static pressure, and Gage No. 172 to determine blower speed for residential air conditioners.

For more information circle **929** on inquiry card.



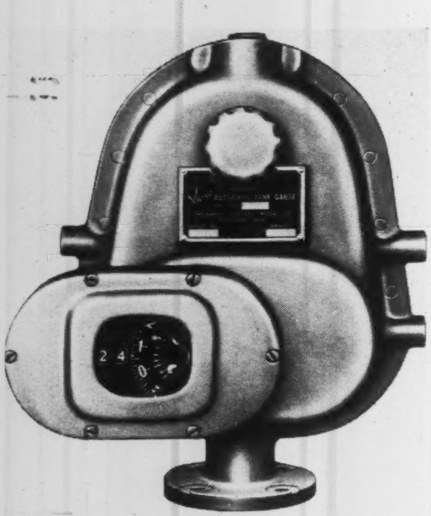
Southwestern Industrial Electronics (SIE) will display its Model DRF Flow Indicating System with magnetic amplifier computer.

For more information circle **930** on inquiry card.



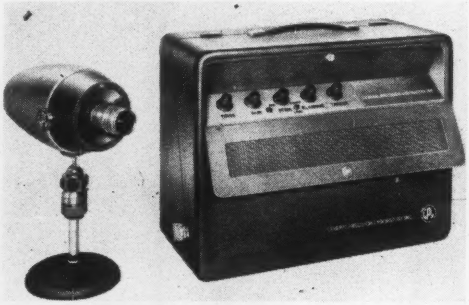
The Moore Products Co. booth will feature this new valve positioner that uses a pneumatic force-balance system to position the valve-motor piston and uses the output of any dc electric controller.

For more information circle **931** on inquiry card.



An automatic top reading tank gage for high pressure service up to 300 psig will be featured by The Vapor Recovery Systems Co.

For more information circle **932** on inquiry card.

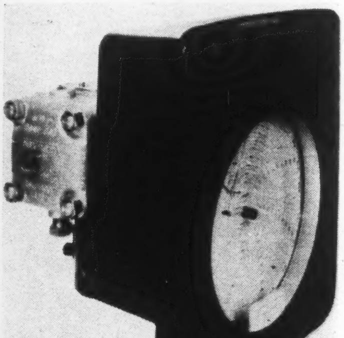


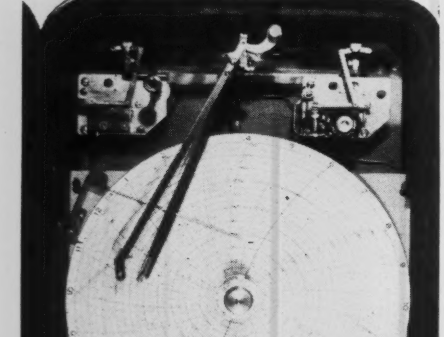
General Precision Lab will have its new closed-circuit precision television system Model PD-150 on display.

For more information circle **933** on inquiry card.

Foxboro's array of new products will include the stacked-diaphragm flowmeter Type 37, the Type 16A pneumatic speed transmitter with a signal linearly proportional to rotational speed, the Model 56-1 pneumatic computing relay, the correction-free gas density cell, and a 1" magnetic flowmeter (not illustrated.)

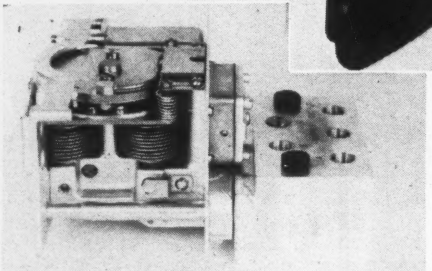
For more information circle **934** on inquiry card.

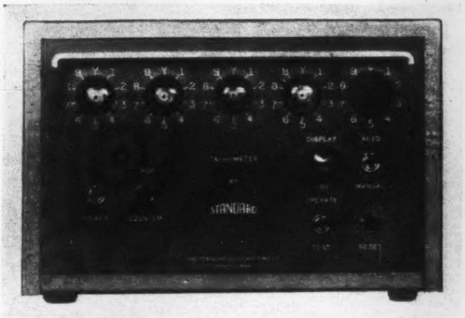




U. S. Gauge Div. will introduce a new series of test gauges, a newly designed series of low-pressure diaphragm gauges, a pneumatic transmitter, and their Gotham cut-cam program recording controller.

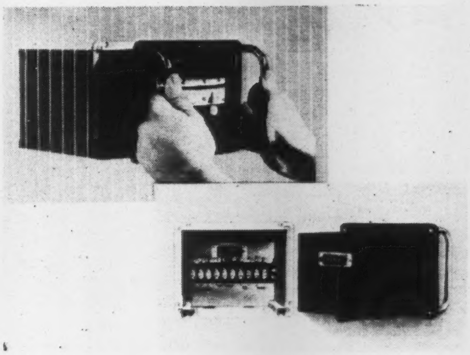
For more information circle **935** on inquiry card.





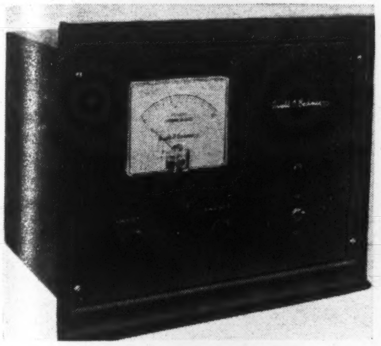
▲Standard Electric Time Co.'s new Electronic Tachometer Model ETC has plug-in assemblies, counts RPM, rate or frequency by counting electrical pulses for an accurately timed interval.

For more information circle **936** on inquiry card.



▲West Instrument Corp. will show new plug-in-type equipment consisting of temperature controller with hand grips, and housing with matching socket and external wiring block.

For more information circle **937** on inquiry card.



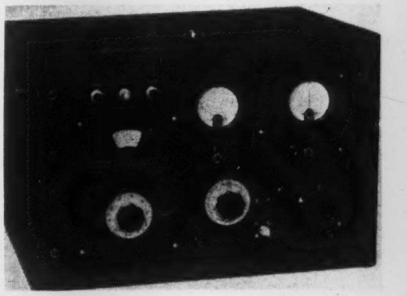
▲Arnold O. Beckman, Inc. will show its new thermal-conductivity gas analyzer for carbon dioxide, hydrogen, ammonia, etc.

For more information circle **938** on inquiry card.

FP
4 3 2 5.0
DIGITAL FLOWRATE INDICATOR

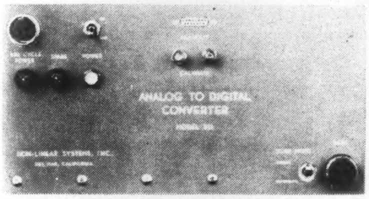
▲Fischer & Porter Co. has developed a new direct-reading digital indicator designed primarily for use with the company's turbine flowmeters.

For more information circle **939** on inquiry card.



▲Measurements Corp.'s new products at the show will include the Model 95 FM Standard Signal Generator.

For more information circle **940** on inquiry card.



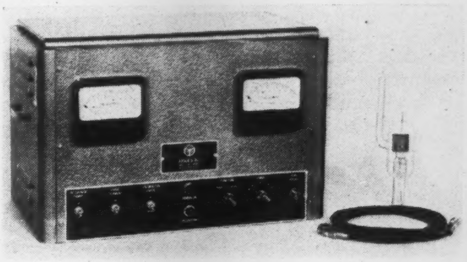
▲A new analog-to-digital converter, Model 311, will be shown for the first time by Non-Linear Systems, Inc.

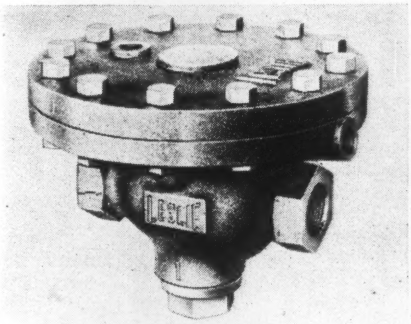
For more information circle **941** on inquiry card.

▶

New ionization gages will be George E. Fredericks Co.'s firsts at the show.

For more information circle **942** on inquiry card.

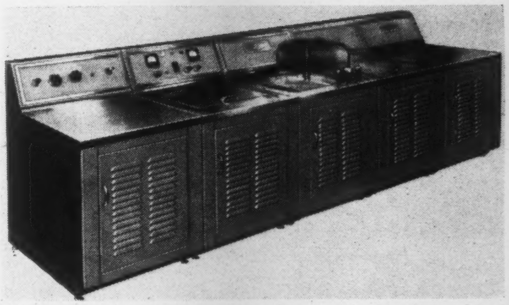




◀

Leslie Co. will present a new air loaded, diaphragm operated, pressure reducing valve for steam heat and process steam applications.

For more information circle **943** on inquiry card.

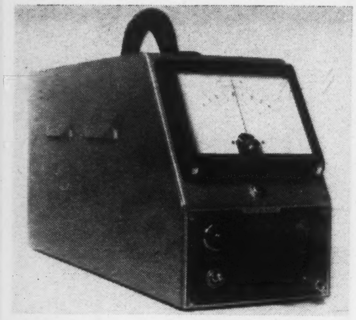


▲Pioneer-Central of Bendix will present this five-cabinet ultrasonic cleaning system with complete cleaning, rinsing and drying facilities.

For more information circle **944** on inquiry card.

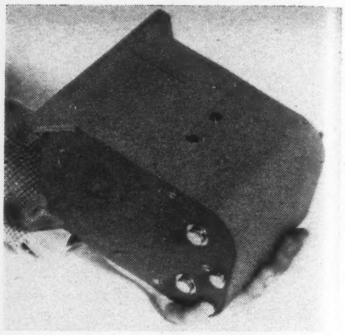
W. & L. E. Gurley will display a digital converter (shaft position quantizer) designed to measure shaft position by photoelectric means. The 13 zone coded disc resolves shaft position into 8,192 discrete angular positions.

For more information circle **945** on inquiry card.



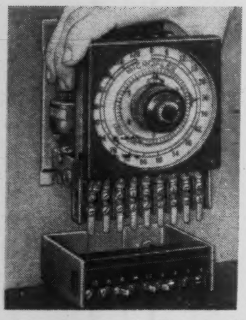
This electronic null indicator, with a sensitivity of 0.001 microampere per mm. will be shown by the Rubicon Co.

For more information circle **946** on inquiry card.



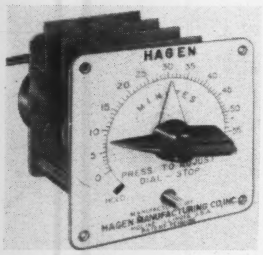
This new 14-channel oscillograph is said to have successfully recorded impact shocks in excess of 3,000 g's. It will be shown at the Midwestern Instruments booth.

For more information circle **947** on inquiry card.



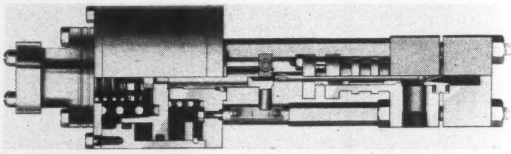
Eagle Signal Corp. will show their improved "Microflex" reset timer with time ranges from 0.3 second to 120 hours.

For more information circle **948** on inquiry card.



New multiple circuit, single interval timer, with time ranges from 15 seconds to 1 hour, will be shown by the Hagen Mfg. Co.

For more information circle **949** on inquiry card.



The Annin Co. will display a new series of valves designed for working pressures to 6,000 psi.

For more information circle **950** on inquiry card.

OTHER EXHIBITS INCLUDE:

HELICOID GAGE DIV.—Two new 3½″ pressure gages (in the Bristol booth) including a sensitive air receiver gage for remote indication of pressure signal from a pneumatic transmitter, and a new gage for applications that require the gage to be revolved about its center during installation.

For more information circle **951** on inquiry card.

HEISE BOURDON TUBE CO.—Pressure gages with an integral movement, externally accessible bleeder, and other new features, with accuracy of 1 part in 1 thousand.

For more information circle **952** on inquiry card.

COMPUTER-MEASUREMENTS CORP.—Direct reading electronic counters of the coincident type, Model 310 Series.

For more information circle **953** on inquiry card.

TECHNICAL PRODUCTS CO.—Model TP-625 Frequency Analyzer automatically scans 14 individual channels simultaneously.

For more information circle **954** on inquiry card.

RESEARCH CONTROLS—New precision-made stainless steel needle valve with rating of 3500 psig at 350° F

For more information circle **955** on inquiry card.

DRIVER-HARRIS—Patented new thermocouple #242-#33 for high temperatures withstands reducing atmospheres.

For more information circle **956** on inquiry card.

GOW-MAC—Hot operation (225°C) thermal-conductivity cells for gas chromatography.

For more information circle **957** on inquiry card.

BECKMAN INSTRUMENTS, INC.—Electrolytic hygrometer capable of measuring one part of water in a million parts of air, a new gas chromatograph for the analysis of gases and liquids boiling to 80°C or below, and new continuous-flow paper electrophoresis apparatus that will handle dyes and intermediates.

For more information circle **958** on inquiry card.

BERKELEY DIV., BECKMAN INSTS.—New radiation detector systems, portable digital flow indicator systems, inline readout indicators, console-controlled electronic brain, wind tunnel control system for pressure and temperature and newly developed frequency measuring equipment.

For more information circle **959** on inquiry card.

CRESCENT ENGINEERING AND RESEARCH CO.—A miniaturized carrier measurement system.

For more information circle **960** on inquiry card.

PERKIN-ELMER—New Model 154-B Vapor Fractometer which permits fast analysis of gases and liquids with boiling points up to 300°C at operating temperatures up to 225° C.

For more information circle **961** on inquiry card.

HAMMEL-DAHL CO.—First showing of a modified 3000 Series standard diaphragm control valve.

For more information circle **962** on inquiry card.

CONOFLOW CORP.—New electric motor actuator for positioning control valves, a low-time-constant control system for pneumatic cylinder actuators, and an electropneumatic positioner for proportional positioning of pneumatic controls in response to electronic signals.

For more information circle **963** on inquiry card.

HOKE INC.—New stainless steel union bonnet globe needle valve designed with interchangeability of parts and body styles to satisfy widely varying operating conditions.

For more information circle **964** on inquiry card.

THE PARKER APPLIANCE CO.—New mounting stud for support of tubing lines.

For more information circle **965** on inquiry card.

THE PARTLOW CORP.—Four new temperature controls.

For more information circle **966** on inquiry card.

PHOTO CHEMICAL PRODUCTS—New photo marking method for permanent markings on nameplates, dials, etc.

For more information circle **967** on inquiry card.

SUPERIOR ELECTRIC CO.—Automatic voltage regulators, including a tubeless magnetic type, and their new line of "Powerstat" variable transformers.

For more information circle **968** on inquiry card.

TAYLOR INSTRUMENT CO'S.—Scanning and logging systems.

For more information circle **969** on inquiry card.

TEMPIL CORP.—Newly developed "Tempilstik" for 575°F.

For more information circle **970** on inquiry card.

U. S. ELECTRICAL MOTORS INC.—New pneumatic control for their "Varidrive" power unit.

For more information circle **971** on inquiry card.

THE OHMART CORP.—Two new products including; a package gage for precision measurement of small diameter pipes, and a motor driven level gage for wide range liquid level measurement.

For more information circle **972** on inquiry card.

OFFNER ELECTRONICS—Direct writing recording Dynographs, now available in rack-mounted enclosures with four recording media.

For more information circle **973** on inquiry card.

MINE SAFETY APPLIANCES—A water vapor analyzer, thermal conductivity analyzer, infrared analyzer, oxygen recorder, combustible gas analyzer, and new "Soundscope" sound level meter and analyzer.

For more information circle **974** on inquiry card.

MAGNAFLUX CORP.—Several new groups of electronic test instruments including magnetic field and coercive force meters, ultrasonic thickness measurement instrument, etc.

For more information circle **975** on inquiry card.

LEEDS & NORTHRUP CO.—New conductivity cells for dip and immersion measurements; "Speedomax" sulfuric acid recorder; "Speedomax" conductivity difference re- order; pH electrodes and mountings; pressurized 0_2 gas ampling equipment; new guarded Wheatstone bridge; ew volt boxes; new "Speedomax" controller for SO_2 gas; nd an auctioneering control assembly that selects and measures the hottest (or coolest) of many primary elements.

For more information circle **976** on inquiry card.

C. M. KEMP MFG. CO.—Absorptive dryers and steam and electric reactivated instrument air dryers.

For more information circle **977** on inquiry card.

THE BURROUGHS CORP.—"Beamplexer", an electronic switch used to sample up to ten separate signal sources and put them out in sequence on a single line.

For more information circle **978** on inquiry card.

AMERICAN INSTRUMENT CO.—New spectrophotofluorometer that permits assays of substances in concentrations as low as 0.1 micrograms.

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MILTON ROY CO.—New controlled-volume pump that uses 3-15 psig air signal to adjust capacity.

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NORTH AMERICAN PHILIPS CO.—Inverted Spectrograph holding three specimens.

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UNIFLOW VALVE CORP.—Series 800 small flow control valves that withstand a wide range of working pressures and temperatures.

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ELECTRONIC RESEARCH ASSOC'S.—"Transpac" line of fixed voltage, semiconductor-transistor-regulated dc power supplies.

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DAVIES LABS.—Automatic switching discriminator used for playback of FM carrier signals from magnetic tape.

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PRECISION SCIENTIFIC—Dual Recordomatic Titrometer claimed to be the first instrument that titrates, automatically controlling the rate of reagent feeding, and records. Also exhibited will be an automatic distillation apparatus.

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BRANSON INSTRUMENTS, INC.—Will introduce their new "Vidigage" designed for non-destructive thickness measurements and flaw detection, and the "Sonogen" ultrasonic generator for bench cleaning of small parts.

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ACRO—New BM-12,000 series subminiature snap action switches operates in temperatures from −100°F to 350°F.

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Journal of the S C M A . . .
SOUTHERN CALIFORNIA METER ASSOCIATION

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Automatic Logging

T. W. ROBERTS, JR.
Fischer & Porter Co.

Automatic data logging opens the way to extensive digital instrumentation in the process industries. Here are the basic elements and features of a typical data logger, with details on the handling of pressure and flow signals.

ONE of the first large-scale applications of analog recorders and later controllers to continuous processes was in the petroleum refining industries. As processes expanded in volume and complexity, instrumentation was expanded to cover more and more variables—level, density, velocity, pH, etc. In an attempt to keep all variables under control of the operator, the next logical step was to group the instruments together on panelboards, with suitable telemetering systems being interposed between the actual measurement of the variable and the panelboard on which it is recorded and/or controlled. However, measurement and visual display of the instantaneous value of hundreds of variables on a single panelboard rapidly reached the point where significance of the variable in the process presented a difficulty in training new personnel and in enabling the operator to keep abreast of the process.

This has led to the comparatively recent innovations in the process industry instrumentation field—the advent of graphic panels and miniature instruments in a central control room. Thus, we have advanced from the use of individual recording controllers mounted locally, scattered throughout the process, requiring a large staff of operating personnel observing all phases of operation and control by wandering in and around the process equipment, to the centralized control of the complete process in the hands of a single operator. The purpose of this trend has been to cut down personnel required to operate the plant as well as to increase plant efficiency.

These economies have not been achieved without some disadvantages. Grouping of hundreds of instruments together in a compact space makes servicing difficult; there are cases on record where a whole process has been shut down accidentally by a serviceman dropping a screw driver in the workings of a console, short circuiting primary control equipment. Likewise the operator is responsible for continuous visual scanning of hundreds of variables. A series of disturbances leaves the operator no time to continue manual logging of the values of the variables and material balance totals, so that subsequent analysis by supervisory personnel as to what happened and in what order is next to impossible because of lack of information being recorded during the critical period. Even damage to the refinery has been caused by faulty operator reaction.

September Meeting: *Thursday, the 20th, Rio Hondo Country Club, Downey, Calif.*
Feature: *W. D. Foote and M. J. Taves, Richfield Oil Corp., will present a talk on "Unit Operation of Oil Fields."*

An industry suffering such a loss rapidly becomes interested in digital instrumentation with fully automatic logging. Of course most instrument engineers today will recognize its advantages, when the facts are presented, before plant damage has occurred.

Advantages of Automatic Data Logging

1. A data logger will automatically record all temperatures, pressures, flows and other variables periodically on a consolidated log sheet in a central location together with an exact time of reading. The output of such a system therefore appears as neat digital readings on typewritten log sheets.

2. Between this periodic presentation of all data the Automatic Logger will rapidly scan all variables for abnormal conditions where, for example, a temperature has exceeded a preset high limit. Should such an abnormal condition exist, a complete digital recording is automatically initiated with all abnormal points appearing in red; thus, not only is any particular abnormal condition indicated but all other variables perhaps tending to go off-normal, but not yet abnormal, will appear.

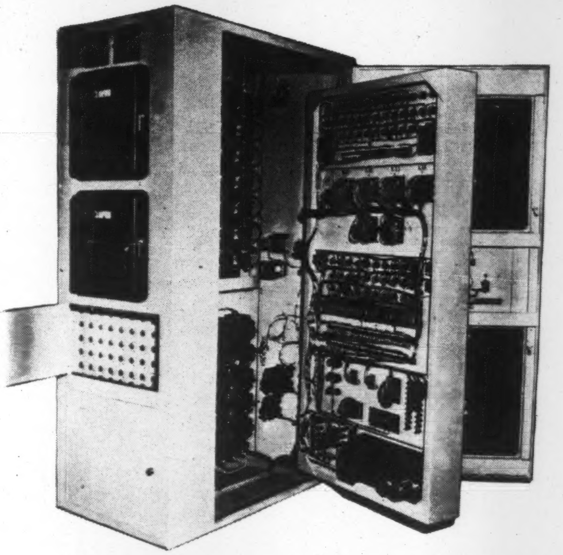


Fig. 1. Automatic logger with access and equipment doors of cabinet open.

3. Flows may be presented as instantaneous flow rates, otalized flows or averaged flow rates either uncompen- ated or fully pressure and temperature compensated. These flows are direct readings, having the square root extracted when read as a function of differential pressure across an orifice. Thus, interpolating charts as well as planimetering is eliminated.

4. The Automatic Logger also produces a punched paper tape, of the type accepted by the Western Union System for the remote transmission of operating data. This has immediate use since the same punched tape may be fed also into the data processing equipment (such as IBM), again saving time and manpower. This tape, fully coded with identifying symbols, will have further uses as a computer input as the industry progresses towards complete automation.

5. During periods of plant upset, when normally no manual log is kept, the Automatic Logger can be set to record the data at more frequent intervals for later accurate evaluation by the supervisory personnel. It can also pin-point current trouble spots so that operators can then take immediate corrective action.

6. Plant efficiency can be increased by logging data which digital instrumentation can handle accurately, but which conventional analog instruments can not handle at all. A refinery installation is now under construction to print operating criteria or control guides such as:

Material balance
Catalyst circulation rate
Carbon burning rate
H_2 in coke
Others

7. Increased accuracy of recording over conventional graphical methods is possible due to elimination of error from pen distortion and drag, paper shrinkage and limited resolution (particularly on miniature-type recorders). In addition, and perhaps most important, use of digital instrumentation avoids contending with analog measurements degraded thru manual interpretation of graphs, manual integration, and final manual computation with all the inherent human errors possible. There is never the possibility of an operator, for example, taking what he considers to be an educated guess as to what the reading is without actually looking at an indicator.

8. As all data are presented on a single log sheet, the inefficient practice of correlating one variable with another on rolls of strip charts is eliminated. The complete picture of the plant's operating conditions is presented with a common time reference on a single sheet.

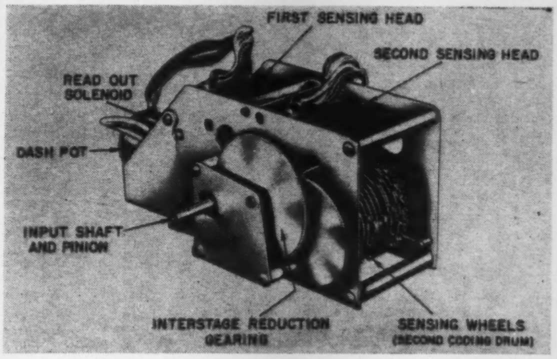


Fig. 2. "Digi-Coder" electromechanical digital converter.

9. Space requirements for the modern centralized control room are continually growing. Digital instrumentation reverses this trend and reduces or replaces the graphic panel, to a large extent providing all the necessary controls and data presentation in a space no larger than a standard executive type of desk.

10. Inputs for the Automatic Logger can be obtained from conventional pneumatic and electrical primaries, making it possible to install the Logger at existing process and production facilities.

Equipment Description

1. *Automatic Typewriter.*—Once an hour, or at other pre-set intervals, the Logger automatically records all variables on an automatic typewriter which produces, simultaneously, a tabulated digital log and punched tape storage. At the beginning of each readout cycle, time is recorded to the nearest minute. The operator can manually initiate a readout cycle by pushbutton, or may vary the frequency of the automatic readout cycle by rotating a control.

2. *Forms.*—The tabulated digital log is recorded on a preprinted set of forms, having main and individual column headings, specifically prepared to meet operating requirements.

3. *Cabinet.*—A fully enclosed cabinet (Fig. 1) measuring approximately 2½ x 4½ x 8 ft houses all pneumatic and transducing equipment as well as all relays, stepping switches, programming devices, potentiometers, power supplies, indicating lamps, controls, etc. The cabinet is provided with gasketed doors and connections for an air purge line. The doors of the enclosure are interlocked so that opening them automatically deenergizes the equipment. Integration is performed continuously regardless of door position, since the integrators meet hazardous-area requirements. Thus the equipment may be serviced between hourly readings without loss of essential data.

4. *Console.*—A two-pedestal-type console, measuring approximately 30 inches high with a top surface 38 x 78 inches, is supplied for mounting the digital output equipment. The desk console is arranged for automatic remote operation and the only interconnections between the cabinet and the console are electrical.

Principle of Operation

Electrical signals, including thermocouple emfs, are fed directly into the point scanner (Fig. 3), which is an automatic programmer. It selects all input signals in a

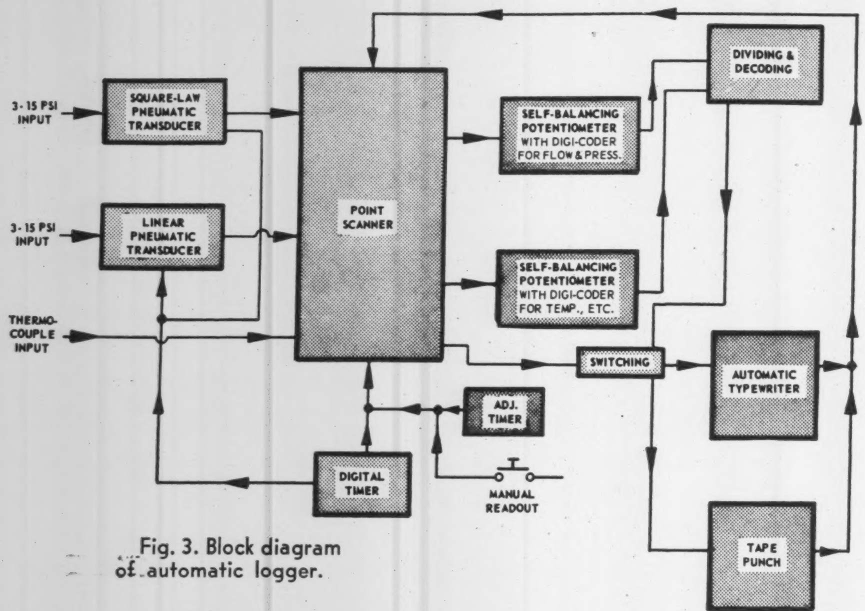

3-15 PSI INPUT
SQUARE-LAW PNEUMATIC TRANSDUCER
3-15 PSI INPUT
LINEAR PNEUMATIC TRANSDUCER
THERMO-COUPLE INPUT
POINT SCANNER
SELF-BALANCING POTENTIOMETER WITH DIGI-CODER FOR FLOW & PRESS.
SELF-BALANCING POTENTIOMETER WITH DIGI-CODER FOR TEMP., ETC.
DIVIDING & DECODING
SWITCHING
AUTOMATIC TYPEWRITER
ADJ. TIMER
DIGITAL TIMER
MANUAL READOUT
TAPE PUNCH

Fig. 3. Block diagram of automatic logger.

pre-arranged sequence, feeds the signals into the proper measuring instrument, changes the input circuitry in accordance with the type of input being received (flow, pressure, temperature), and selects the proper range in the dividing and decoding network. The leads from all inputs terminate at point selector switches whose contacts are gold-plated to insure trouble-free service.

Two self-balancing measuring instruments usually are provided with the Automatic Logger. One of these is a potentiometer with calibrated slidewires for various thermocouple ranges; special linearizing slidewires are provided in order to produce linear shaft rotation output for nonlinear inputs. A "Digi-Coder" digital converter is geared to the bull-gear of the self-balancing instrument and converts shaft position to digital output. The digital output of the "Digi-Coder" digital converter is fed to the dividing and decoding network. A "Digi-Coder" is shown in Fig. 2.

The second self-balancing instrument (used for inputs from the flow and pressure transducers) has a resistance-type bridge circuit.

Flow Circuits

Flow measurements to be integrated are received as 3-to-15-psig pneumatic signals from conventional pressure transmitters. These signals are converted into electrical signals by a comparator and an accumulator (Fig. 4). The comparator is a differential-pressure element consisting of two chambers separated by a limp diaphragm. Associated with this limp diaphragm is an electrical contact assembly. The accumulator consists of a precision potentiometer driven through a slip clutch and differential mechanism by a synchronous motor, and by a zero reset motor. Also associated with the accumulator mechanism are (1) an integrating clutch which, when energized, allows the synchronous motor to drive the precision potentiometer, and (2) a mechanical memory circuit which stores energy by mechanical means during a readout.

The 3-to-15-psig input signal is connected to one side of the comparator. The other side of the comparator is connected to a limited-volume manifold, common to all flow inputs. The pressure in the manifold is determined by a pneumatic transmitter operating from a 2-rpm synchronous motor through a square-law cam (for square-root extraction). Manifold pressure continues to sweep from 3 to 15 psig and back to 3 psig at a rate of 2 full cycles per minute. In this service the transmitter acts as a common transducer for all flow inputs.

At the start of each sweep cycle all integrating solenoids are energized because all input pressure signals equal or exceed 3 psig. The integrating synchronous motors continue to drive their respective potentiometers until the rise in manifold pressure opens the contacts of their respective differential-pressure elements. Therefore, during a sweep cycle, each potentiometer advances by an increment linearly proportional to the time required for manifold pressure to equal the input pressure signal of that potentiometer. Since this time is proportional to the square of the pneumatic input signal, a linear relationship is established between flow signals and the incremental advancements of their integrating potentiometers. Manifold pressure sweeps continuously, causing cyclic potentiometer advancements, the sum of which is an integral of flow. Normally the accumulator is allowed to integrate flow for an hour, when a readout automatically takes place.

At the start of a readout cycle individual brake assemblies on the accumulators are energized, "locking up" flow measurements simultaneously. Thus, while a sequential readout may take from 1 to 7 minutes, all flows are measured at the same time. During the sequential readout of the integrated flow measurements, integrating motors are not allowed to drive the shaft of their precision potentiometers on the accumulators. The memory solenoid and brake holds the readout potentiometers motionless. As integration continues during the readout cycle the integrating motor continues to operate, but stores measurement data received during readout in a spring mechanism.

At the end of a readout (other than one occurring at the end of a flow accumulation cycle) the memory solenoids are released and the spring mechanisms used to store flow data unwind, turning their precision potentiometers through the same rotational distance they would have traversed had they been continuously connected to the integrating motors. Should a particular readout cycle also constitute the end of a flow accumulation cycle, a signal causes the zeroing motors to drive their integrating potentiometers to the zero position. A differential between the integrating motors and the zero reset motors allows reset action without interruption of integration. After a 40-second period allowed for zeroing, the memory solenoid and brake is released. Again the spring mechanisms, in unwinding, turn their integrating potentiometers through the same rotational distances that would have been traversed had they been connected to the integrating motors during the readout and reset periods.

Zero reset of the flow potentiometers normally occurs automatically only after the hourly readouts (and a 24-

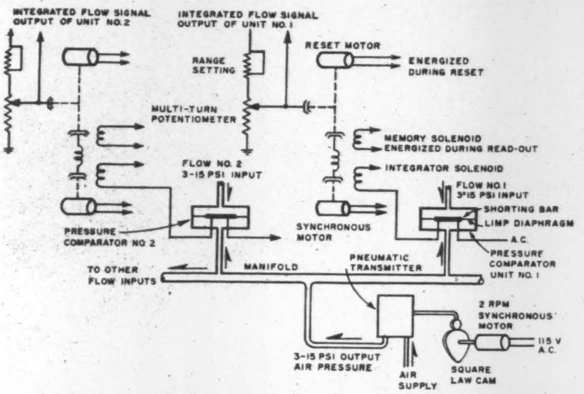

INTEGRATED FLOW SIGNAL OUTPUT OF UNIT NO. 2
INTEGRATED FLOW SIGNAL OUTPUT OF UNIT NO. 1
RESET MOTOR
RANGE SETTING
ENERGIZED DURING RESET
MULTI-TURN POTENTIOMETER
MEMORY SOLENOID ENERGIZED DURING READ-OUT
FLOW NO. 2 3-15 PSI INPUT
INTEGRATOR SOLENOID
FLOW NO. 1 3-15 PSI INPUT
SHORTING BAR
LIMP DIAPHRAGM
PRESSURE COMPARATOR NO 2
SYNCHRONOUS MOTOR
A.C.
PRESSURE COMPARATOR UNIT NO. 1
TO OTHER FLOW INPUTS
MANIFOLD
PNEUMATIC TRANSMITTER
2 RPM SYNCHRONOUS MOTOR
115 V A.C.
3-15 PSI OUTPUT AIR PRESSURE
AIR SUPPLY
SQUARE LAW CAM

Fig. 4. Flow input circuit. Pressure in common manifold is swept from 3 to 15 psig at a rate of 2 cycles per minute. Sweep waveform is characterized by square-law cam for automatic square-root extraction.

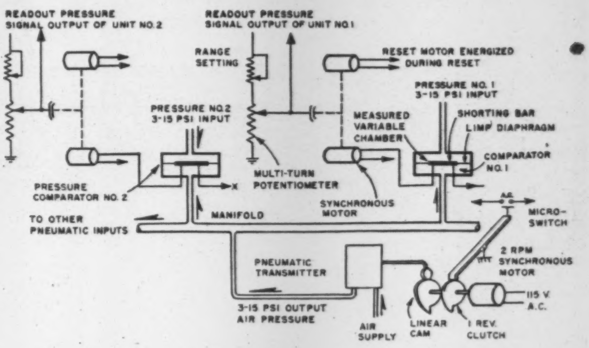

READOUT PRESSURE SIGNAL OUTPUT OF UNIT NO. 2
READOUT PRESSURE SIGNAL OUTPUT OF UNIT NO. 1
RANGE SETTING
RESET MOTOR ENERGIZED DURING RESET
PRESSURE NO. 1 3-15 PSI INPUT
PRESSURE NO. 2 3-15 PSI INPUT
MEASURED VARIABLE CHAMBER
SHORTING BAR
LIMP DIAPHRAGM
COMPARATOR NO. 1
X
MULTI-TURN POTENTIOMETER
PRESSURE COMPARATOR NO. 2
SYNCHRONOUS MOTOR
A.C.
MICRO-SWITCH
TO OTHER PNEUMATIC INPUTS
MANIFOLD
PNEUMATIC TRANSMITTER
2 RPM SYNCHRONOUS MOTOR
115 V. A.C.
3-15 PSI OUTPUT AIR PRESSURE
AIR SUPPLY
LINEAR CAM
1 REV. CLUTCH

Fig. 5. Conventional pressure inputs are handled as in Fig. 4 except that a linear cam is used to develop a linear sweep.

hour readout if desired). Manual readouts, or a readout actuated by the adjustable timer, normally will not cause the flow potentiometers to reset. Zero reset, if necessary, can be accomplished at any time by a key-operated switch.

Integrated flows are thus set up as electrical signals on the integrating potentiometers and are read in sequence. Temperature, pressure and other variables to be averaged are measured and stored as described for integrated flow inputs.

Other Pneumatic Inputs

Other pneumatic inputs received as 3-to-15-psig signals are converted into electrical form by similar means (Fig. 5). A comparator and a readout potentiometer are employed for each input. The comparator is the same device described for integrated flows.

The input pressure is connected to one side of the comparator while the other side is connected to a manifold common to all pressure comparators. Pressure in the manifold is determined by a pneumatic transmitter, operating as a transducer, from a synchronous motor through a *linear cam*. A pressure transmitter is operated at the beginning of each readout cycle, causing the pressure in the manifold to vary linearly from 3 to 15 psig. The synchronous motors drive their respective potentiometers until the rise in manifold pressure opens the contacts of their comparators.

Pneumatic inputs to be recorded as instantaneous values are thus set up as electrical signals on the readout potentiometers and are read in sequence in the same manner as other electrical and thermocouple emf input signals. Regardless of the time required for sequential readout, all inputs are measured simultaneously in a single sweep cycle. At the end of each readout, the readout potentiometers are reset by the action of the zero reset motor. The system then remains de-energized until the next readout.

Most components have a life expectancy in excess of 10 years. The comparators are accurate to plus or minus 1/8″ of water over a temperature range of minus 5 to plus 150° F; will withstand over-pressure in either direction of 200 psi. The unique bellows material is noted for toughening with age and is rated at 25,000,000 flexures. The advantage of the comparator over an amplitude-sensitive device such as a nonlinear bellows is obvious.

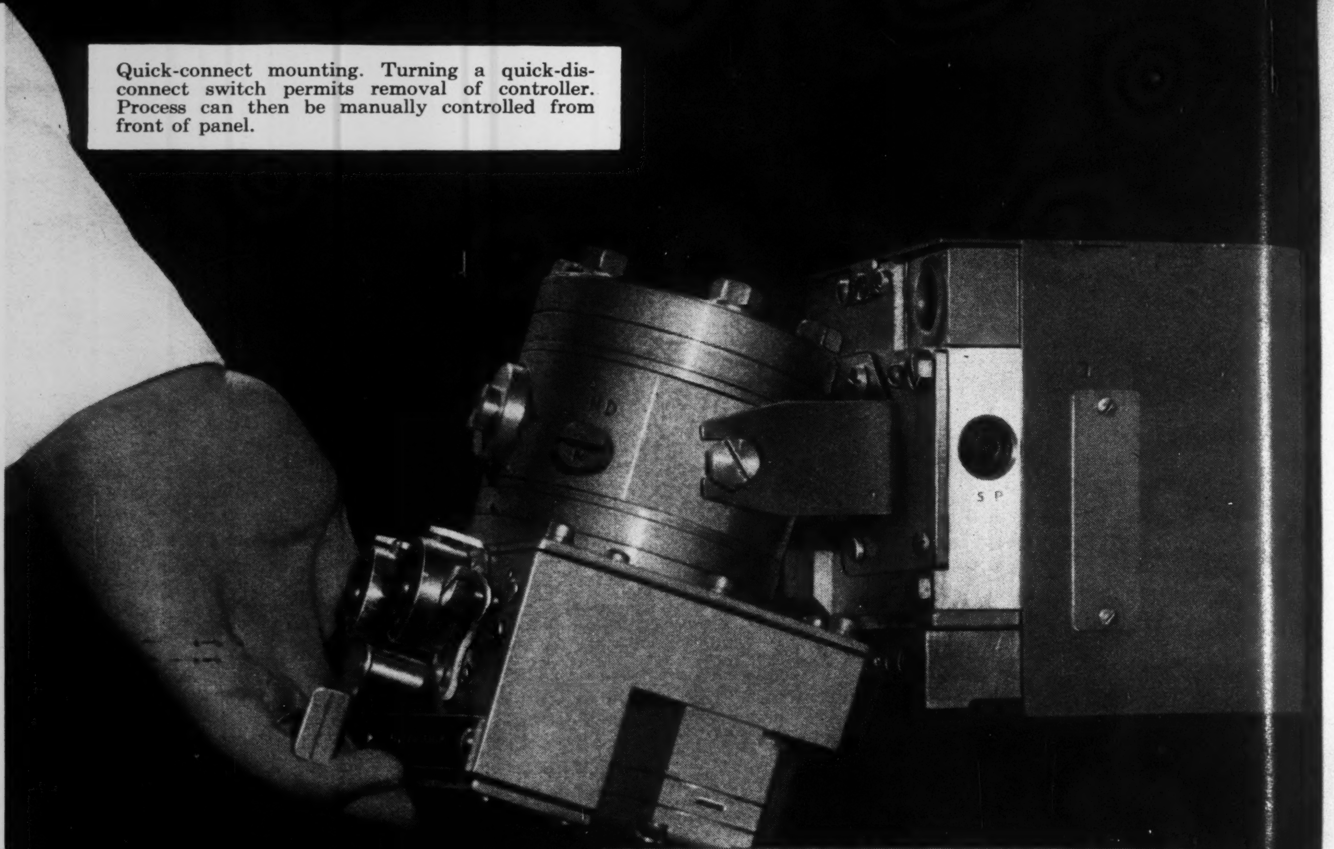
The pneumatic transducer system employed is easily rescaled when scale changing is desired, without recalibration or shutdown of the Automatic Logger. Scale changing is a mechanical adjustment wholly independent of the pneumatic transducer system. Thus, with the exception of the self-balancing potentiometer and pneumatic transmitter, the entire Automatic Logger is unitized in quick-disconnect components which are interchangeable and may be replaced at any time without affecting system operation or calibration.

A "Digi-Coder" digital converter is geared to the bull gear of each instrument. A digital dividing circuit is employed at the output of the "Digi-Coder" digital converters so that the same accuracy may be obtained regardless of differences in range. For example, the circuitry is such that the range of 0-1500, 0-750, 0-375, and 0-137 all employ full-scale deflection of the self-balancing potentiometers.

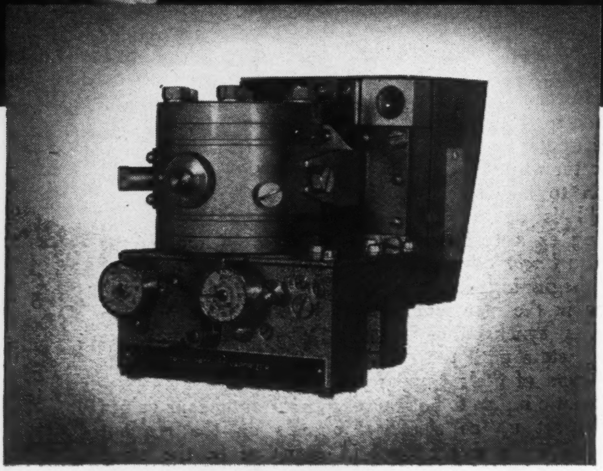
Reliability and maintenance costs of Automatic Data Handling Systems compare favorably with conventional instrumentation. The stepping switches used for the programming are suitable for 250 million steps. Under normal operation and allowing for a recording every half hour, a life expectancy of 30 years is obtained for these switches. The "Digi-Coder" digital converter gives 5 million readouts without replacement and a life expectancy of 5 years.

Self-checking devices to assure continuing accuracy of Automatic Loggers are readily provided. For electrical inputs, one check channel can be supplied to printout either at the beginning or end of each readout cycle. This channel should read 1000 or some other convenient round number; recording of any other value indicates an error. A single pneumatic channel is employed for a similar calibration check of each common pneumatic transducer.

Many Automatic Logger users have justified their Data Reduction installations in parallel with all existing conventional instrumentation. After gaining confidence in the digital system, many firms are curtailing the indiscriminate use of analog recording instruments. Considering that an Automatic Data Logger can pay for itself during plant start-up by virtue of presenting all data on one log sheet and by scanning all variables for abnormal conditions, it is well to investigate the feasibility of Automatic Data Handling systems as an alternate to conventional analog instrumentation, to eliminate costly manual data handling and manipulation, to obtain better quality control and increase production, and to simplify instrumentation requirements.

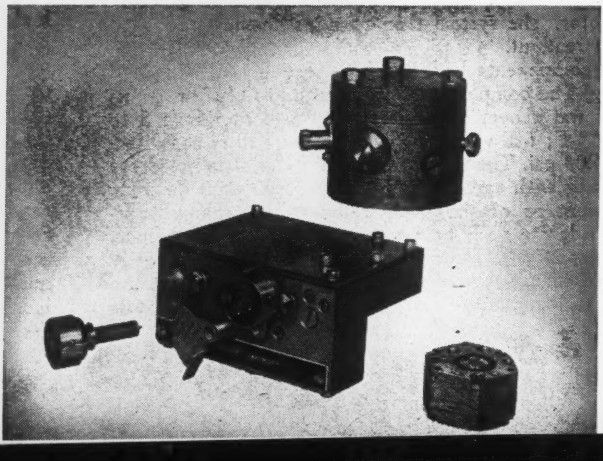


Quick-connect mounting. Turning a quick-disconnect switch permits removal of controller. Process can then be manually controlled from front of panel.



All adjustments, filters and restrictions are accessible on the face of the controller. ▲

Unitized construction permits easy replacement of all major components. ▼



PROPORTIONAL-PLUS-RESET CONTROL

Tel-O-Set controllers incorporate two pneumatic chambers which receive two transmitted air pressures—one from a measuring unit, the other from a control-point-setting unit. They respond instantly to differences between the two transmitted air pressures by diaphragm movements which adjust the controlled air output to return the controlled variable to its set point.

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control any process variable with one TEL-O-SET controller

THERE'S just one model of the adjustable band *Tel-O-Set* controller . . . and you can use it to control flow, temperature, pressure, or any other variable. It has the speed of response, high sensitivity, and on-the-job versatility to simplify many control problems.

If necessary, you can remove one *Tel-O-Set* controller and replace it with another in a few seconds. Downtime is minimized. Maintenance is simplified. Your spare parts inventory is reduced. And you can easily change processing techniques without buying additional instruments.

Three reset ranges—Tune control action to suit any process with the *Tel-O-Set* controller . . . change the reset range to fast, intermediate, or slow—just by repositioning a single screw.

Compensated rate action—You can easily add rate action to the basic model . . . before the deviation section . . . so that overshoot on batch processes is held to an absolute minimum.

Unitized construction—Each component of the *Tel-O-Set* controller can be replaced with an identical precalibrated component. Needle valves and seats of proportional band and reset adjustments are entirely enclosed and cannot be damaged.

Quick-connect mounting—Mount the *Tel-O-Set* controller on the back of the recorder, on the valve, or anywhere between. A single lever opens or closes all interconnecting air lines . . . allows manual control after the controller is removed. The controller will match up perfectly with the flat, gasketed rear of the recorder.

Made by the world's largest instrument manufacturer, *Tel-O-Set* controllers have demonstrated outstanding performance in countless applications over the years. Call your nearby Honeywell sales engineer for a discussion of how you can profit by their many advantages. He's as near as your phone.

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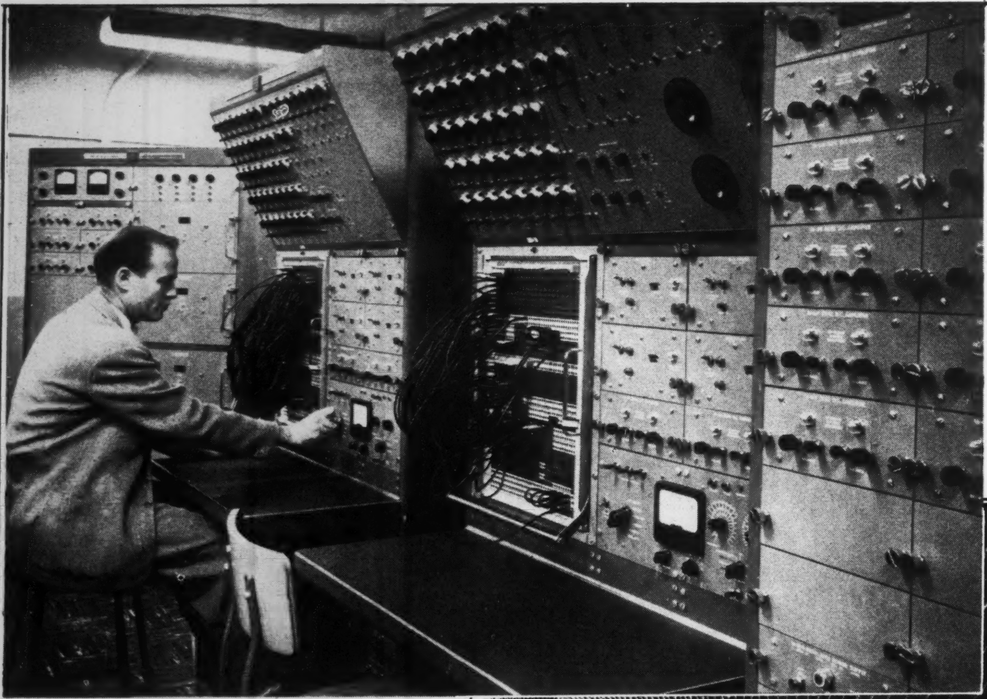
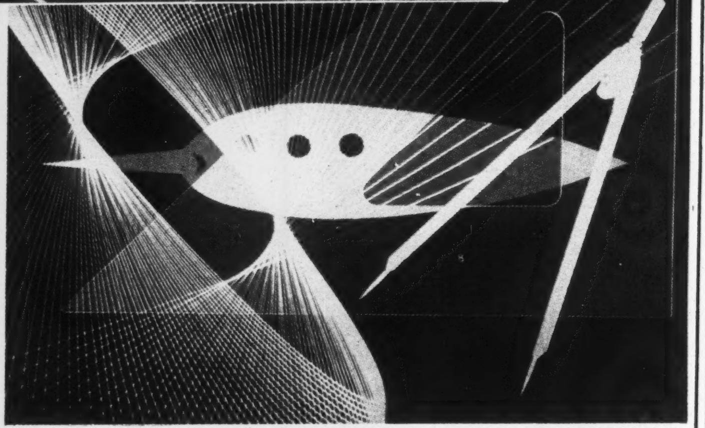


Trust PACE for Progress . . .

North American Aviation, Inc.

A flip of the operating console switch by advanced Mathematician John R. Chapin starts operation of Electronic Associates' Precision Analogue Computing Equipment (PACE) in the Computer Room of Autonetics, a division of North American Aviation, Inc. PACE Equipment is employed here to determine both design parameters and refinements of an aircraft's advanced, radar—equipped fire control system. One more example of PACE Equipment serving progress in major industries. Complete details on the flexibility and the reliability of PACE Analogue Computing Equipment will be forwarded to you immediately. We will also gladly furnish you with information on the rental of time and computing systems at the Electronic Associates' Computation Center in Princeton, New Jersey. Just write department IA-8, Electronic Associates, Long Branch, New Jersey.



Pre-flight tests of AUTONETICS flight control systems are simulated in special analog computers while the planes that will use them are still on the drawing board.

Now man can fly a plane before it's built

For many years there were problems in the design of aircraft which could not be solved practically except by trial and error—a slow, costly, often dangerous method.

Today much of this guesswork and time, as well as some of the hazard, has been eliminated—thanks to newly designed electronic devices. Now specially designed computer systems simulate on the ground actual conditions of supersonic flight...help predict the performance of aircraft which are still on the drawing board.

Although actual flight will always be the final test of any aircraft, these special uses of computer systems by the AUTONETICS Division of North American Aviation are daily helping solve complex problems in less time and with more certainty than ever before ...speeding scientific break-throughs in the whole intricate field of advanced electro-mechanical systems—auto pilots, auto navigators, automatic armament controls, and other automatic control systems.

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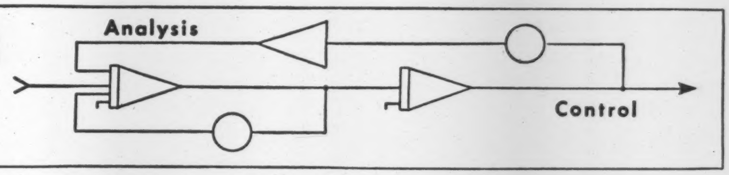
The SIMULATION COUNCIL *Newsletter*



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CONVAIR ANALOG COMPUTER LABORATORY

The first of the unique features of Stan Rogers' Analog Computer Laboratory (Convair-San Diego) to impress the visitor is its sheer size—and we don't mean floor space, but capacity. There are some 728 operational amplifiers plus a complete complement of all the other kinds of equipment which go to make up a well-balanced analog computing facility. And the equipment is operated 24 hours a day, five days a week, with Saturday devoted to maintenance. So far as your Ed. knows this makes it the largest and busiest analog computing facility this side of the iron curtain—and, *I sincerely hope,* in the world!

The next thing that impresses a visitor on his first visit is probably the variety of equipment. There are Electronic Associates, Reeves, and Goodyear operational amplifiers; Mid-Century and Goodyear electronic multipliers (with some of the new EA ones due in shortly), and gosh knows how many makes of other equipment.

A feature not so immediately apparent is the extreme versatility of the installation. The equipment is located in three rooms on two floors, and in all there are 17 analog console stations which can be used individually or connected in any combination for larger problems. As if this were not enough, the Epsco Addaverters (Analog-Digital-Digital-Analog conVERTERS) are scheduled for delivery in September to allow the combination of any or all this equipment with Convair's ERA 1103 and subsequently their IBM 704.

Additional features contributing to the versatility of the Convair installation are: a large proportion of general-purpose amplifiers; control relay connections on the patchboard; a portable remote control box which can be taken to the test stands which, besides the Reset, Operate, Hold switch, has three function switches and can be used to remotely set 20 computer pots.

Also of interest are the servo-set pots furnished by EA and Kay-Labs. The former are set from a keyboard while the latter can be set from a manual voltage divider or a special static IBM card reader furnished by Dynalysis Labs, Santa Monica.

The recently received EA equipment has an automatic equipment-checking system developed with Convair cooperation, by means of which one man can completely check out the equipment in 10 or 15 minutes per station, as contrasted with the requirement of five men working for 1½ hours to check out the older equipment. This equipment also features the EA problem-check system.

Many of the special features of the Convair Analog Computer Lab are for the purpose of speeding set-up and check-out time, because with 17 stations and three shifts it might be necessary to set up as many as 51 problems in 24 hours! Thus it is easy to understand why a modernization problem is under way to add, among other things, a Reeves-type problem check system to the rest of the equipment.

Besides all this Stan has a CRC 105 Digital Differential Analyzer.*

With all the foregoing equipment, involving some 6600 tubes, is it any wonder that they are setting up an IBM card failure-analysis program?

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*For informtion on the DDA Council, write Stan Rogers at 3023 Alcott St., San Diego, Calif.

Pieces

MEETING OF WESTERN S/C OF JULY 12 ON "COMBINED ANALOG-DIGITAL SIMULATION"

Fifty-six representatives of 27 organizations were guests of Convair at the Institute of Aeronautical Sciences in San Diego on Thursday, 12 July.

At a Steering Committee meeting in the morning Joe Hussey (Berkeley Division of Beckman Instruments, Richmond, Calif.) was elected first Treasurer of the Western Simulation Council. (We have never had a treasurer before for the very good reason that we have never had any money before. And we don't have any now, but we've got plans!) The Steering

Committee also nominated candidates for Assistant Chairman of the Western Simulation Council's Steering Committee (to succeed to the chairmanship in six months), and discussed the coming National Simulation Council Steering Committee meeting to be held in Denver on the 30th of August in connection with the Third Annual Symposium, "Digital and Analog Computers", under the auspices of the Denver Research Institute. At the Denver meeting the National Council, in the person of ye Ed., is planning a panel on "Combined Analog and Digital Simulation".

After lunch (a buffet at the IAS cafeteria—very good, too) our chairman Jack Sherman (Lockheed Missile Systems Div., Van Nuys, Calif.) announced the subject to be discussed as "Combined Analog and Digital Simulation"* and called on Stan Rogers, who is in charge of the Simulation Laboratory at Convair-San Diego, to explain their thinking on the subject. Stan said that the people who are to do the Convair combined simulation are engineers with problems rather than computer facility personnel, and asked Bob Leger (Convair-Astronautics Div.) to take over.

Leger on Combined Simulation

Jack Sherman interjected that he hoped Leger would tell us, among other things, *why* they are making a combined simulation. Bob gave as reason the fact that they want to simulate a complete weapon system accurately and yet be able to tie in operating hardware. They need the analog as a sort of buffer between the digital computer and the hardware, if nothing else. Another reason for the analog equipment is that with hardware in the system you must operate in real time, and you are limited as to the amount of computation you can do with your digital computer and still keep up in real time. They therefore use the analog computer to unload the digital one by putting on those computations not requiring great accuracy, or those involving rates with which it would be difficult for the digital computer to keep up. Their tendency, however, is to do what they can on the digital machine.

Bob explained that the Analog-Digital-Digital-Analog converter "Addaverter" equipment which they expect to get gives 17 binary digits plus sign, but this does not mean that they expect to get accuracies of one part in 131,072. They have asked for that number of digits, not for extreme accuracy but for good accuracy plus a wide dynamic range. In a closed-loop process, if a variable starts off at 100 volts, the purpose of the closed loop is to get the variable to zero with good accuracy. You can operate with considerable error when the value is large. The crucial thing is the accuracy at zero. They could not use anything good to one part in 1,000 of *full-scale voltage.* This would allow zero inaccuracy of 1/10 of a volt—not good enough. So the specs were set to require an accuracy of one part in 1,000 of the *actual* voltage, whatever it is, or one millivolt, whichever is larger. The specs of the equipment, which is to be provided by Epsco, Inc., are actually 2 to 1 better than that; i.e. ½ a thousandth and ½ a millivolt.

Besides accuracy, a very important factor in conversion equipment is timing. For instance, if you wish to sample the three components of a vector, all the samples must be taken at the same time. Because they are all changing with time you have to be careful about the simultaneity of your sampling.

Convair's original specifications were very liberal to allow for several design approaches. They only required that the total time to convert an analog voltage to a digital number would be not more than 10 milliseconds. This plus an additional delay in the computation can be somewhat corrected for by using prediction computations in the digital computer extrapolation procedures. The Addaverter which Convair is to get is all-electronic and will make this analog-to-digital conversion in about 85 microseconds. This is fast enough to make unnecessary the requirement that the analog voltage be held constant while a conversion is being made. Although the reading you actually get is somewhere between that of the voltage at the time you start and the voltage at the time you complete your conversion, no storage is required.

John McLeod (Convair-Astronautics Div.) referred to Bob's figure of some 85 microseconds to convert from analog to digital, and said that in the Epsco Datrac (the ten-bit plus sign equipment which his group was going to show later in connection with the tour) the reverse conversion, from digital to analog, takes only two microseconds, and asked Bob if this were true of the Addaverter.

The first specification called for three milliseconds, Bob said. As before, they wanted a long time to allow for design flexibility. However, the all-electronic equipment which they hope to get is much faster. In it the analog voltage is presented and held at the output until the next digital sample is presented at the input. Then the jump from the previous voltage to the new voltage introduces a transient. Though Epsco does not believe it will take more than 20 usec, they hold the analog voltage for approximately 100 microseconds for the transient to die out. Bob said that there was no use for them to stick to anything like two microseconds because they do not need such speed.

McLeod questioned Bob's earlier statement that the digital number representing a changing voltage would be somewhere between the value of the voltage at the beginning and at the completion of the conversion. He explained that a Datrac having a 100-volt range would first sample to see whether the analog voltage was above or below 50 volts, then above or below 75 or 25 volts, etc. It would seem that Bob's equipment, which works on a similar principle, would end up giving the final value of the analog voltage because the least significant digit is the last one to be established.

Bob said not necessarily. If a signal is changing extremely rapidly, the next to least or some more significant digit, having been previously established, might be in error by the time the conversion is completed.

Irwin Pfeffer (Ramo-Wooldridge Corp., Los Angeles, Calif.) stated that George West at R-W had looked into the possibility of programming a digital computer to determine at exactly what time the indicated voltage actually occurred.

Bob Leger asked whether this program used a prediction based on previous values and extrapolation from them.

Irwin replied that he thought so.

Jack Sherman asked again if Bob would mind giving us more of an insight as to just why they were making this combined simulation. When you consider all of the inaccuracies like those resulting from phase shift through the converter and noise in the input information, do you gain anything by the extreme accuracy of your digital computer?

Bob answered that there are some parts of the system in which you need much more accuracy than others.

Jack agreed, but insisted that extreme accuracy is not necessary if your input data are not pretty good, especially in a closed-loop system.

---

*Yes—same subject as that of the panel discussion at Denver.

Bob said sure, but the hardware in the system you are trying to simulate may also be pretty crude and pretty rough. There are such things as stiction, friction, and so forth which are hard to represent. The purpose of the closed loop is to determine accurately what is happening as a result of these things, and to correct for them.

Jack agreed that this was a reason for using hardware in the loop; what he wanted to know was why they used the digital computer.

Bob pointed out that a system with a very crude autopilot might wander all over the place, but if there is provision for making actual measurements to find out what is going on and correcting for it, these measurements must be more accurate than the autopilot.

McLeod inquired if it was too dangerous a generalization to say that dynamic systems, as typified by the aerodynamics of an airframe, can usually be handled better by analog methods; and that the kinematics of the system, as typified by a navigational problem, might be better handled by digital techniques.

Bob said his reaction to the question was mixed. The dynamics of the system tend to involve the high frequencies and you don't need very great accuracy—in fact, you don't have accurate input data—whereas the navigational problem tends to involve low frequencies but will require greater accuracy. Overall this might be looked at as a navigational problem with high-frequency perturbations imposed on it. From this point of view it can be considered that the high-frequency effects with poor accuracy should be done by analog methods and the low-frequency with high accuracy by the digital. However, Bob would not say that aerodynamic effects are necessarily handled better on an analog system—if you don't have to work in real time. "If you don't have to work in real time you can do an awful lot on a digital machine."

McLeod agreed that the analog computer has certain inherent inaccuracies, but if a reasonably complex system is described almost completely by a set of simultaneous differential equations, when it comes to solving those equations there are also inherent inaccuracies in the digital computer such as the round-off and truncating errors. Assuming that both an analog and digital computer are large enough and fast enough to handle the problem, and that you must operate in real time, what is likely to be the comparative magnitude of the inherent errors of each computer? Would the digital errors amount to as much as the ½% which might be obtained by careful use of an analog computer?

Bob replied that assuming a quiet system and a digital machine as large and fast as you wish, you can get around the round-off error by using a long word length, and the truncation error by using a small enough time interval. But in a practical machine, of course, there are definite limitations, so the answer depends on the frequency content of the information.

Bill Waddell (Giannini DATEX, Pasadena, Calif.) remarked that the coarseness of the approximations which you are always required to use will more than outweigh errors caused by round-off and truncation.

Dov Abramis (Convair-Pomona) said that his group is running digital checks of their analog computation on their Datatron computer at the rate of something like one digital check for every hundred analog runs. However, even when using rather sophisticated integrating techniques to allow them to use larger integration intervals, the Datatron takes from one to three hours to check a one-second analog run. Dov wondered if Bob had worked out a faster integration technique.

Bob said this might be a question of how complete Dov's simulation was; that they were neglecting a lot of things of the type which he said were more suitable for the analog equipment. On the analog machine they try to set up a reasonable representation of the perturbations about a reference, and then on the digital machine they handle the navigation problem and do not have to worry about the dynamics.

Pfeffer pointed out that so far the desirability of a combined analog-digital simulation had been tied to the fact that it was necessary to include hardware in the system, but that this was not the only justification. If a purely digital system were to be set up to simulate in reasonable detail all of the high-frequency effects which can be taken care of by analog equipment in a combined simulation, the time required for a solution might be 100 to 1,000 times as great as that required by combined simulation. Therefore even if it is not necessary—or not possible—to speed up to real time, a great deal of computing time may be saved by a combined system, particularly where repetitive runs are to be made for statistical or other reasons.

Jack Sherman heartily agreed, and said that there was also a matter of cost involved, which had so far not been mentioned. He thought he remembered from an earlier discussion at Ramo-Wooldridge that the digital computer actually did a comparatively small part of the problem.

Irwin Pfeffer replied that this was not true; it did a very vital part of the problem.

Jack repeated, vital but small.

Irwin said yes, but it was a part that could not otherwise be done. There is a large class of problems which can be done all digitally, but which cannot be done by all-analog methods.

Hans Meissinger (Hughes Aircraft Co., Culver City, Calif.) precipitated a discussion of the effect of integrating noisy errors versus integrating offset errors, indicating that the former might be averaged out but that the latter would be cumulative.

Bob agreed, and said that this had led them to duplicate some of their computations and do them both ways. In these cases the analog will give them the instantaneous values at all times while the digital is used to correct for any offset effects.

Mike Foley (5226 Radford Ave., North Hollywood, Calif.) said that he thought the question of *why* had been very thoroughly answered. What he would like to hear was *how*.

However, Jack suggested that the answer to that one be deferred until after the break because Convair's coffee and doughnuts were ready.

* * *

After the break Dov Abramis was elected Assistant Chairman of the Steering Committee of the Western Simulation Council in an election so close that three counters couldn't agree on the number of hands (some people were holding up both hands perhaps?). So those voting had to be divided on opposite sides of the room!

After the politics Jack Sherman reopened the discussion by referring to Mike Foley's question of how the combined simulation is to be accomplished, and asked for anyone familiar enough with the Epsco conversion equipment to draw a block diagram on the board.

Paul Sherertz (Convair-San Diego), who had been helping to set up

SIMULATION COUNCIL

the demonstration of the Datracs, volunteered to do this.

Looking at Paul's diagram, Dov Abramis said that it seemed to him that the greatest difference between the Convair and the Ramo-Wooldridge system was that at Ramo-Wooldridge the analog and digital computers were adjacent to each other, whereas at Convair they were not. He asked what effect the long lines between the Convair computers might have.

Paul replied that the only long lines were about 800 feet long between a unit adjacent to the 1103 and the analog computer. The only change required was this unit, which generates long pulses from the short pulses of the computer.

Jack Sherman asked whether anyone knew the cost of the conversion equipment.

Henry Low (Ramo-Wooldridge Corp.) and Irwin Pfeffer ducked this one, Irwin answering very cagily that it was in six figures.

"Is the first figure a one or a nine?" asked Jack.

"The first digit is not a nine."

McLeod explained that the cost was influenced by the fact that this was not standard equipment, but special equipment developed to specifications originated by Convair and subsequently adopted with modifications by Ramo-Wooldridge. The price therefore reflects a good bit of development cost.

Jack observed that yes, this was indeed special equipment, but probably everybody who gets into this field will need "special equipment", and therefore we can expect the price to remain high.

By contrast McLeod pointed out that the little Datrac which was to be demonstrated later that afternoon is a "shelf item" which sells for less than $10,000. Though it will handle only 10 digits plus sign, it still represents quite a difference in relative cost. It is a single-channel device in *either* direction, but not in both simultaneously.

Jack suggested that one could time-share it to use it as a two-way channel.

Asked what the sampling rate of Epsco equipment was, McLeod said that when free-running it is 2 microseconds per digit, or 22 microseconds in the case of the 10-bit plus sign Datrac. The usual penetration is parallel but when the register is cleared, a serial pulse train is available. However, if you present a parallel binary code, the whole transformation is made in two microseconds if you disregard the transient (as Bob Leger was not willing to do).

In answer to a question from Joe Hussey, McLeod said that the Datrac was specified as accurate to within ½ of the last significant figure.

Asked whether, if one were willing to spend more money, higher accuracy would be obtainable, McLeod suggested that as the equipment which we were discussing was pressing the state of the art, we will probably not be able to get more accuracy at any price for some time to come.

INFORMATION (Without Theory)

Last spring Bernie Gordon, president of Epsco, was very unhappy (i.e. maddernhell, with your Editor, 'cause I implied in the *s/c Newsletter* in the Feb. issue of *Instruments and Automation* that there was skepticism regarding Epsco's ability to deliver hardware any time in the near future which would meet their advanced performance specifications. Now, six months later, I am happy to say that I have seen and even touched some *delivered* hardware which I have every reason to believe will meet specifications. The first week in July the Convair-Astronautics Division Data Reduction Group received four Model B "Datracs". A week later two if these were shown to those visiting the Convair-San Diego Analog Computer Laboratory in connection with the Western Simulation Council meeting. Both Datracs were connected to a common variable voltage source, and for various settings the two binary codes, as read out on the panel neon lights, agreed to the least significant of ten binary digits plus sign, i.e. one part in 1024. Time did not allow a more sophisticated demonstration, but we are now planning one.

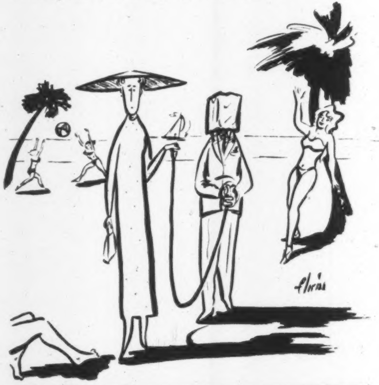
Proceedings of the National Simulation Conference held in Dallas, January 1956, are available at $5 each from Professor F. W. Tatum, Electrical Engineering Department, Southern Methodist University, Dallas, Texas (checks payable to Institute of Radio Engineers).

Through personal contacts your Editor has been kept reasonably well-informed concerning plans of various companies in the simulation field, including Electronic Associates plans for a West Coast analog computing center. However, I have never been able to get permission to release any of the EA information, so can only repeat here what has come to me as scuttlebut—i.e., that the installation of something in the vicinity of 100 amplifiers and suitable companion equipment will be available to prospective simulation and analog computer customers sometime before December of this year, in the vicinity of Los Angeles International Airport. Wish I could tell you who is going to run it, but so far this seems to be a secret.

It is also interesting to note that Reeves is opening a Santa Monica office to be run by R. T. Franzel, following closely on the heels of Mid-Century's appointment of Norm Irvine to open a Los Angeles office. These follow by more than a year EA's sending of Jim McCloskey to open a West Coast office.

Thot (rejected)

Last month in this space Ye Ed. suggested that "Science is only controlled curiosity." A friend of ours, one F. P. Nessosis, took exception to this broad generalization and backed up his argument with an illustration of "controlled curiosity" which is certainly not science. See cut.



Computer Events

Other events on page 1490

National Simulation Council

Date: 30 August 1956

Place: Denver Research Institute
Denver, Colo.

Subject: Panel Discussion, "Combined Analog and Digital Simulation" and Meeting of the National Steering Committee

Information: Simulation Council,
8484 La Jolla Shores
Drive, La Jolla, Calif.

Association for Computing Machinery
Date: 27-29 August 1956
Place: University of California at Los Angeles, Los Angeles 24, Calif.
Subject: 11th Annual Meeting
Info: ACM, Box 3251, Olympic Station, Beverly Hills, California

Denver Research Institute, University of Denver
Third Annual Symposium on Digital and Analog Computers
Date: 30-31 August 1956
Place: Hotel Albany, Denver, Colo.
Info: William B. Kennedy, D.R.I., University of Denver, Denver 10, Colo.

Western Simulation Council
Date: 13 September 1956
Time: 1:00 PM
Place: North American Aviation, Downey, California
Subject: 1. Introduction to North American Simulation Facility
2. The North American Bendix Three-Dimensional Flight Simulator (Flight Table)
3. Problems of Physical Simulation
Clearance: Confidental. Please request Security Clearance NOW, as we know from experience that you won't get in without it. Contact H. Sehlers.

Eastern Simulation Council
Date: 24 Sept.
Place: Moore School of Electrical Enginnering, University of Penna., Phila., Pa.
Time: 9:00-11:00 AM (tour); meeting at 11:00 AM.
Subject: Simulation by Modeling and Analogies"
Contact: Bernie Loveman, Reeves Instrument Co.

National Electronics Conference
Dates: 1-3 October 1956
Place: Hotel Sherman Chicago, Illinois
Information: NEC, 84 East Randolph Street Chicago 1, Illinois

Midwestern Simulation Council
Date: To coincide with National Electronics Conference (Oct. 1-3)
Place: Chicago, Illinois
Subject: "Simulation of Hydraulic Systems"
Information: Tammen & Dennison, Engineering Consultants, Chicago, Illinois

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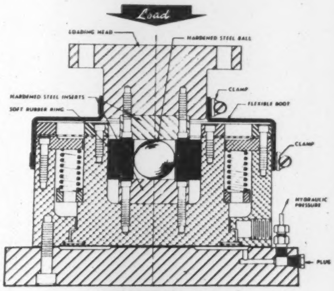

FIGURE 1

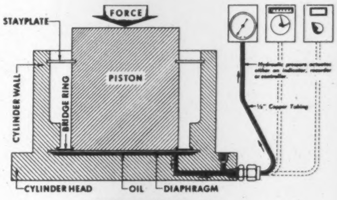

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FIGURE 2

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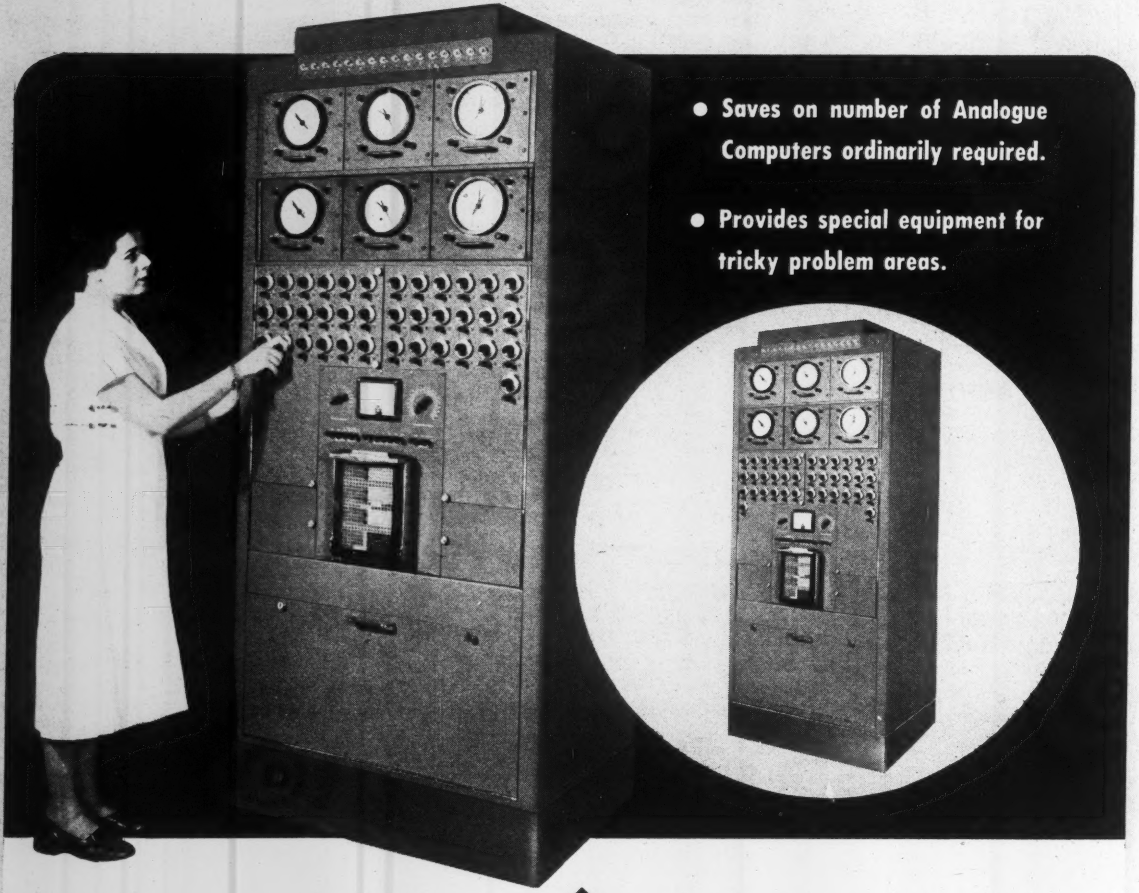

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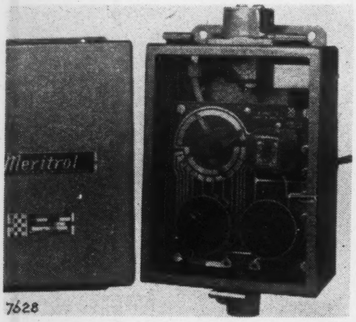
BLOW-DOWN CONTROLLER

New "Merit Type D685 Condensation Control" is housed in an air-tight J.I.C. case; features two selector switches: one determines interval between blow-downs; the other determines duration of this action. Relay operates small solenoid valve mounted and sealed to case. Output of this valve operates diaphragm valve to accomplish blow-down action.

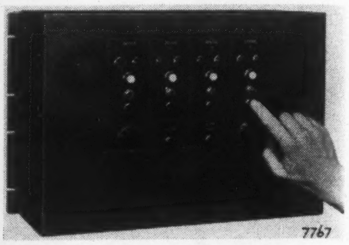


Printed circuits make components readily replaceable.—*Emmett Machine & Mfg. Co., Inc., 445 E. Turkeyfoot Lake Rd., Akron 19, Ohio.*

For more information circle **302** on inquiry card.

SUPERVISORY CONTROL

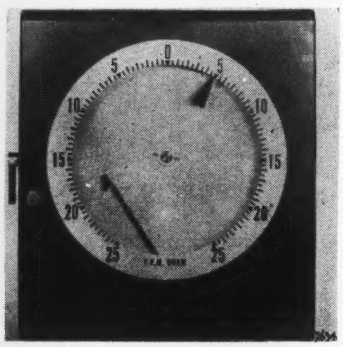
New "Type DOS-3" supervisory control system enables one operator to supervise and control many valves, pumps, motors, etc.; is available in two ultimate capacities, 25 and 50 points.—*Motorola Communications & Electronics, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill.*



For more information circle **303** on inquiry card.

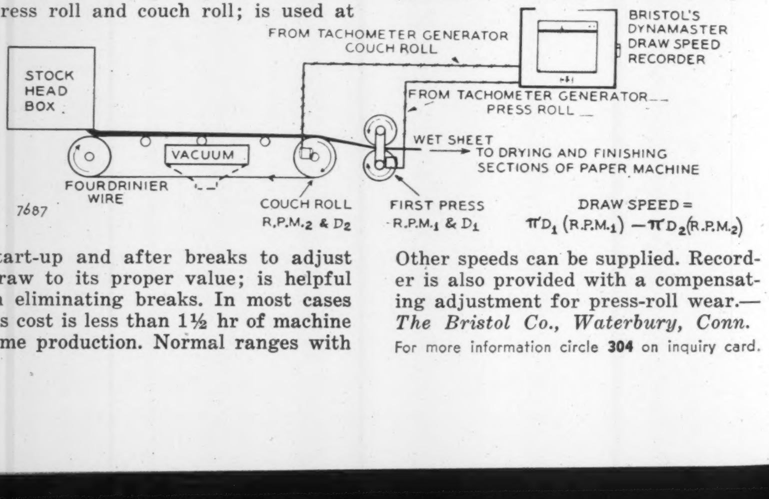
ROLL SPEED DIFFERENCE AND RATIO RECORDER

New Differential Voltage Recorder indicates and records variations in roll speeds for steel or paper mills; is available in two models: one has a scale and chart for direct reading of feet-per-minute "draw" ("stretch" of paper or steel); the other records and indicates ratio between roll speeds. Both are unaffected by changes in



PAPER MACHINE DRAW-SPEED RECORDER

New "Dynamaster Draw-speed Recorder" records arithmetical difference between paper speed over first press roll and couch roll; is used at start-up and after breaks to adjust draw to its proper value; is helpful in eliminating breaks. In most cases its cost is less than 1½ hr of machine time production. Normal ranges with 3-way manual switch: draw-speed 0-100 fpm; couch-roll speed 0-1000 rpm; press-roll speed 0-1000 rpm.


BRISTOL'S DYNAMASTER DRAW SPEED RECORDER
FROM TACHOMETER GENERATOR COUCH ROLL
STOCK HEAD BOX
FROM TACHOMETER GENERATOR PRESS ROLL
WET SHEET
TO DRYING AND FINISHING SECTIONS OF PAPER MACHINE
VACUUM
FOURDRINIER WIRE
7687
COUCH ROLL R.P.M.₂ & D₂
FIRST PRESS R.P.M.₁ & D₁
DRAW SPEED = πD₁ (R.P.M.₁) − πD₂(R.P.M.₂)

Other speeds can be supplied. Recorder is also provided with a compensating adjustment for press-roll wear.—*The Bristol Co., Waterbury, Conn.*

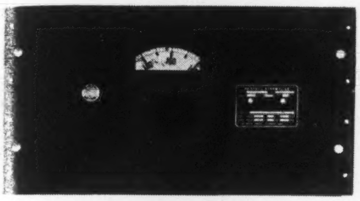
For more information circle **304** on inquiry card.

operating speeds, recording only draw and ratio during speed-ups or slowdowns.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **305** on inquiry card.

POTENTIOMETER OR BRIDGE PNEUMATIC TRANSMITTER

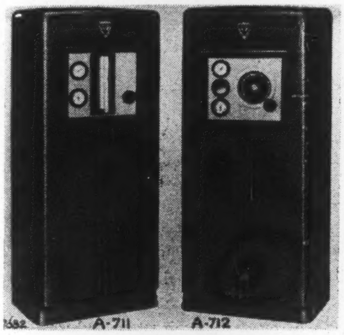
New "Dynamaster Pneumatic Transmitter" is a measuring instrument equipped with a pneumatic transmitter which sends a standard 3-15-psi signal proportional to the measured variable. It is available in either potentiometer or bridge circuit; will measure any variable which can be translated into an electrical measurable and pneumatically transmit this measurement to a remote indicator, recorder, or controller; is available either "blind" or with an indicating scale for at-the-scene measurement.—*The Bristol Company, Waterbury 20, Conn.*



For more information circle **306** on inquiry card.

V-NOTCH CHLORINATORS

New "Series A-711 and A-712" V-notch chlorinators, built entirely with corrosion-resistant materials, feature a new metering and controlling principle—"V-notch Variable-Orifice"; cover a feed range from 25 to 2000 lb per day. "A-711" has a rotameter and "A-712" (wide-range model) has direct-reading dial indication of feed rate. In both, variable-orifice control gives precise and smooth chlorine feed ontrol over an extremely wide range. —*Wallace & Tiernan, Belleville, N. J.*



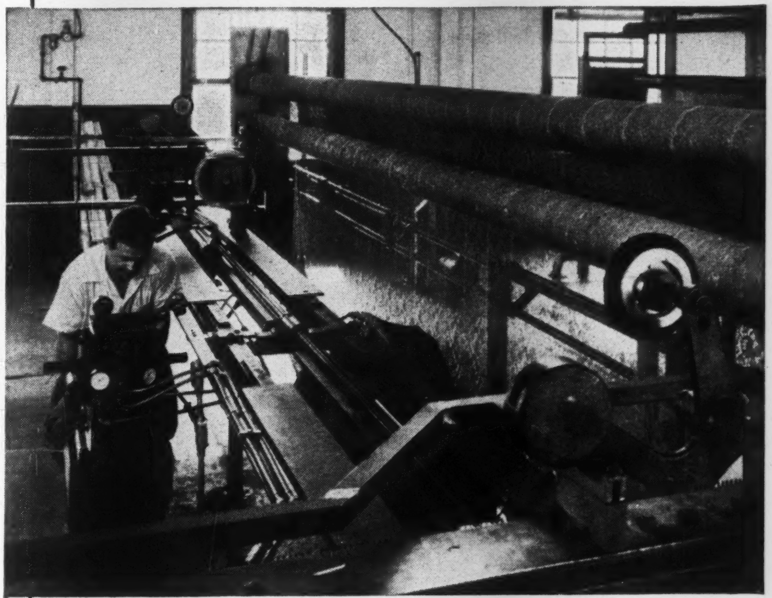
For more information circle **307** on inquiry card.

MULTI-CHANNEL-INPUT PRODUCTION COUNTER

New "Model MC" multi-channel-input electronic counter is applicable wherever total count of daily prod-

FROM...

Tons of Steel to Ounces of Lace Rolls of Paper or what YOU Make



Positive ASKANIA Edge Position Control... for Greater Production at Lowest Cost

• In *any* kind of mill operating at *any* rate of speed producing almost *any* type of material, the ASKANIA EDGE POSITION CONTROL can be a dominant factor in your *profit* picture.

EXAMINE YOUR OWN OPERATIONS

If you PRINT, SLIT, LAMINATE, POSITION, WIND, STEER, TENTER or EXAMINE—or require accurate edge control for any other operation—you can greatly increase your production and decrease manpower cost by applying this proven, automatic, easily maintained control to your line. In the production of PAPER, PLASTICS, TEXTILES, RUBBER, FOIL and SHEET METALS, for example, the Edge Guide Control has practically eliminated the downtime and the wasted materials and manpower previously common to their production. Versatility is practically unlimited!

YOU'D BE SURPRISED!

Edge control can be applied to a great variety of your problems. Do you want to move the material—or would you prefer to move the *tool?* Do you think your edge problem is beyond control? If so, you'd be surprised at the ease of adaptation—the simplicity of operation and maintenance—and above all the accuracy that can be applied to your own problem.

CONTINUOUS CONTROL
HIGH SPEED OPERATION
NON-CONTACT
HYDRAULIC POWER OPERATION
MOST ACCURATE CONTROL
FOR ALL WEB HANDLING
WIDE RANGE

Your first step is to send for our Bulletin No. 161—which explains the purpose, function and operation of the ASKANIA EDGE GUIDE CONTROL. *Write to the* ASKANIA REGULATOR COMPANY, *268 East Ontario Street, Chicago, Ill.*

ASKANIA REGULATOR COMPANY

CONTROLS FOR INDUSTRY
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A Subsidiary of General Precision Equipment Corporation

For more information circle **68** on inquiry card.

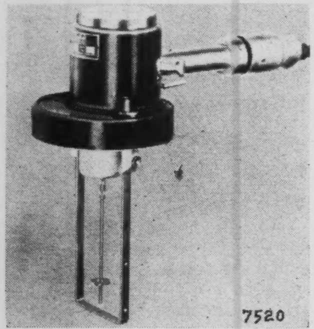
uction is required from more than one line. A single "MC" unit registers an accurate count of any number of production lines. A separate photohead is located on each line where the count is to be picked up. As each object breaks photo beam, a pulse is fed to "MC" which, in turn, relays pulse to counter. Should photoheads be interrupted simultaneously, count will still remain accurate, owing to anticoincidence feature. "Model MC" also provides a method for high-speed "batching" by allowing any number of conveyors to accumulate into one common collection point; also adaptable to accumulating product information where several sources of one product are involved, as in printing the same material on several presses, or accumulating total footage when product is in web form and is processed on several similar machines.—*Post Machinery Co., Beverly, Mass.*

POST electronic
multi-channel
7661

For more information circle **308** on inquiry card.

EXPLOSION-PROOF VISCOSIMETER

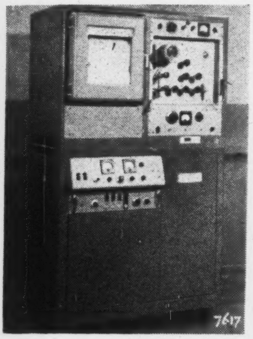
New explosion-proof model of maker's "Viscometer," for use in Class I, Group D locations, has its motor completely encased in a "machined-from-the-solid" aluminum case. All immersible parts are stainless steel. Explosion-proof features UL approved.—*Brookfield Engineering Labs., Inc., Stoughton, Mass.*



For more information cicle **309** on inquiry card.

MASS SPECTROMETER FOR LOW-VP CHEMICALS

New special modification of "Type 21-620 Process-Monitor Mass Spectrometer" enables it to analyze liquid mixtures of gasolines and chemicals which have insufficient vapor pressure at room temperature. It can handle most of the samples that can be analyzed by larger higher-resolution analytical-type mass spectrometers.—*Consolidated Electrodynamics Corp., Pasadena, Calif.*



For more information circle **310** on inquiry card.

MASS SPECTROMETER FOR MULTI-STREAM ANALYSIS

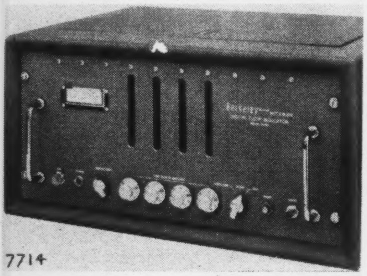
New modification of "Type 21-62 Process-Monitor Mass Spectrometer" permits automatic multi-stream an multi-component analysis by mean of added equipment: automatic programmer, a peak selector, and pipin and valves. In illustrated equipmen there are nine sample lines, eight fo sampling flowing streams, and one fo standard sample, a static supply.—*Consolidated Electrodynamics Corp. Pasadena, Calif.*

For more information circle **311** on inquiry card

FLOW-RATE and VOLUME

DIGITAL FLOW INDICATOR

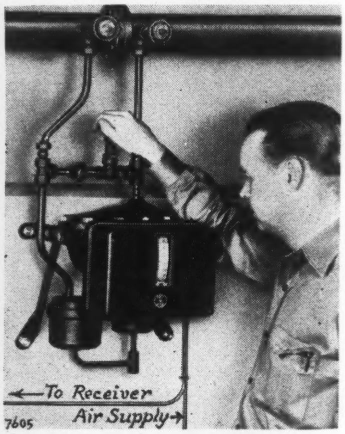
New "Model 5692," said to be "the first complete digital flow indicator system," is a production testing instrument compact enough to move from test bench for calibrating flowmeters and making actual flow measurements. It combines features of maker's "7150 EPUT Meter" and "5424 Preset Counter" and directly indicates flow-rate from zero to 9999 pounds (or gallons) per hour. Time base can be selected from 1 millisecond to 10 seconds, in increments of 1 millisecond. Coincidence tubes connect four time-base selector switches to unit's four preset decimal counting units. Instrument operates with any impeller-type transmitters on market; has a complete test feature whereby any discrepancy between DCU indication and preset counter number immediately reveals any malfunction of system.—*Dep't 3939, Berkeley Div., Beckman Instruments, 2200 Wright Ave., Richmond 3, Calif.*



For more information circle **312** on inquiry card.

HIGH-HEAD FLOW-RATE TRANSMITTERS

New high-head differential pressure transmitters utilize accuracy o mercury U-tubes for measuring flow-rate of steam, water, other liquids, and gases producing maximum differentials from 100 to 1200" H_2O at maximum service pressures of 800, 3500, and 6000 psig. Signals are SAMA standard, 3-15 psig or 3-27 psig. Available receivers indicate, record, and/or integrate. Since signals are linear with flow-rate, measurements can be combined with other related factors on an evenly-graduated chart.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.*



For more information circle **313** on inquiry card

DIGITAL FLOW INDICATOR

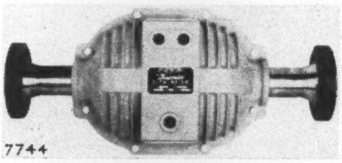
New direct-reading digital flow-rate indicator, designed primarily for use with maker's turbine primary elements, features edge-illuminated inch-high numbers, engraved in clear plastic, readable at 25 ft. Only the relevant number appears and there is no mechanical movement in going from one digit to another. Other features: electrical conversion into desired flow units and correction for primary's calibration factor; true integrated flow-rate; F&P frequency octupler; automatic frequency-controlled range switching; customized time base with long-term stability of 0.1%. Optional: manual specific gravity adjustment. —*Fischer & Porter Co., 758 Jacksonville Rd., Hatboro, Pa.*

FP
4 9 2 5 0
DIGITAL FLOWRATE INDICATOR
7795

For more information circle **314** on inquiry card.

MAGNETIC FLOW-RATE METER BODY

New model of maker's "Magnetic Flow Meter" is available for 1" flow lines, offers all advantages of the larger instruments (2" and up): overall accuracy of 1% of full-scale throughout scale, no restriction of flow, linear flow readings, performance unaffected by pressure, viscosity, density or changes in conductivity of flowing liquid. New 1" meter will handle full scale flows of 10 gpm or greater.—*The Foxboro Co., Foxboro, Mass.*



For more information circle **315** on inquiry card.

PRESSURE-COMPENSATED INTEGRATING FLOWMETER

New "Model 236 Pressure-Compensated Continuous Integrating Flow Meter" combines maker's "Model 199 Rupture-Proof Bellows Unit" and Librascope "Model 90 Pressure-Compensated Flow Computer," indicates both differential and static pressure and continuously totalizes flow on a six-digit counter without use of cams

as small as the tube it cools...
ACTUAL SIZE
EAD's subminiature CENTRIFUGAL BLOWER

Here is the most compact centrifugal blower unit made . . . EAD's high-velocity subminiature centrifugal blower is only 2⅞" long, weighs only 6 ounces, yet it can move 13 cfm of air at a velocity of 3,000 feet per minute—and the volume holds up at high static pressures. It is driven by EAD's new one-inch diameter motor. The metal blower housing can be rotated to any position desired for maximum efficiency in cooling radar equipment, amplifier units, transmitter equipment, oscillators, and in other applications where high temperatures in confined areas demand miniaturized blowers with the highest possible performance characteristics. EAD's subminiature blower units meet all applicable MIL specification, and low temperature rise makes them suitable for high altitude and high ambient temperature operation.

CFM	13 @ 0" SP 10 @ 1.0" SP	7 @ 0" SP 5 @ .2" SP
MAX. SP.	2.5	0.6
RPM	20,000	11,000
AMPS	0.1	0.06
WATTS	10.0	6.0
CAPACITOR Mfd/Volts	0.25/220	0.1/220
WEIGHT (OUNCES)	6	6
MODEL NO.	B2GIQ-C	B2HIY-C

Modifications of standard models or completely new designs can be engineered to meet your special cooling needs. Write for complete information.

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS · CENTRIFUGAL BLOWERS · TACHOMETER GENERATORS · FANS · ALTERNATORS · GEAR MOTORS

347 CENTRAL AVENUE • DOVER, NEW HAMPSHIRE

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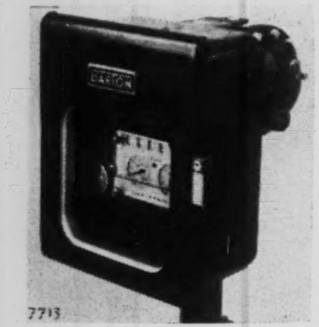


or intermittent devices; has a built-in pulse switch for transmitting reading to a remote data-collecting or automatic-control system. Integrator is available in D-P ranges from 0-2" water to 0-50 psi with static pressure ratings to 6000 psi.—*Barton Instrument Corp., 1429 S. Eastern Ave., Los Angeles 22, Calif.*

For more information circle **316** on inquiry card.

ASPIRATION PYROMETER

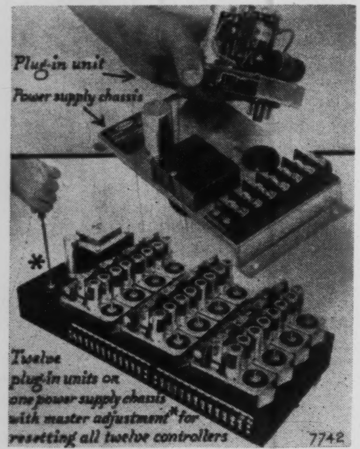
New "Land" suction pyrometer provides accurate measurement of heated gas to 2900°F. by forcing gas at high velocity past thermocouples to maximize convective heat transfer. Suitable indicating and recording instruments can be used in conjunction with it. Complete systems are available. Three models are offered using platinum *vs.* platinum-rhodium TCs, each designed for a particular application and temperature range. Concentric shields of special design are employed to minimize errors. Standard water-cooled stainless steel jacket is 6 ft long but other lengths from 4 ft to 12 ft can be supplied.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.*

For more information circle **317** on inquiry card.

TEMPERATURE

PLUG-IN UNIT THERMISTOR TEMPERATURE CONTROLLER

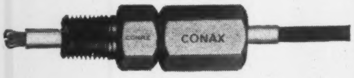
New "Series 53,000" comprises (1) a small high-sensitivity rapid-response thermistor primary element, (2) a plug-in on-off-action automatic control unit, (3) a power supply chassis; features unusual flexibility, chiefly in multi-point installations. Up to 100 plug-in controllers can be plugged into one power supply chassis with savings in space and cost and with ease of resetting all controllers simultaneously by one master adjustment which can be embodied in chassis or located remotely. Each controller, of course, still has its own setting screw which can be used either independently of master or as a fine adjustment. Available ranges (all °F): —100-50, 0-150, 100-300 and 200-600. Electrical ratings: 115 vac 5 amp non-inductive, 230 vac 7 amp non-inductive. Splash-proof, explosion-proof and special housings can be furnished.—*Fenwal Inc., Ashland, Mass.*


Plug-in unit
Power supply chassis
*
Twelve plug-in units on one power supply chassis with master adjustment* for resetting all twelve controllers
7742

For more information circle **318** on inquiry card.

MULTIPLE-WIRE TC GLANDS

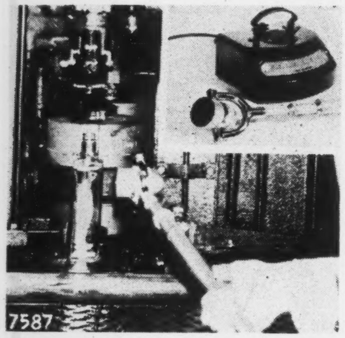
New Multiple Wire Thermocouple Glands provide easy entrance into pressure vessels of 1, 2, 4, 6 or 8 wires by maker's method of sealing bare wires at pressures from vacuum to 20,000 psi; can be used at temperatures ranging from —300°F to 1850°F. This wide range of temperature and pressure is determined by type of sealant used: Neoprene, Teflon or Lava.—*Conax Corp., 7811 Sheridan Drive, Buffalo 21, N. Y.*



For more information circle **319** on inquiry card.

GLASS PYROMETER

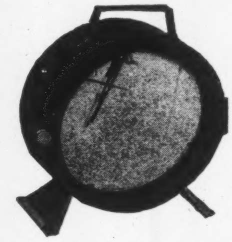
New model of "Land Portable Radiation Pyrometer" measures surface temperature of heated glass; has unusually wide range of 200°F to 1800°F; comprises a measuring head mounted on an adjustable metal pole (which can telescope to 9 ft) and a small galvanometer temperature indicator. Measuring head's receiver responds to long-wave (over 5 microns) infrared radiation emitted by normally transparent or translucent glass. Pyrometer is fully compensated for ambient temperatures and heating of instrument.—*Fielden Instr. Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.*



For more information circle **320** on inquiry card.

PORTABLE RECORDING THERMOMETERS

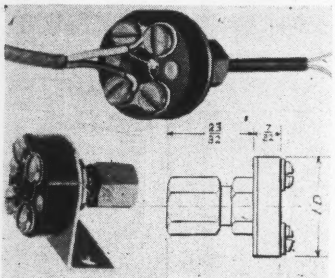
New models of maker's mercury or vapor actuated portable recording thermometers are supplied with 8", 10" or 12" chart, have carrying handle, stand legs, brackets for coiling connection tubing at rear of case and a locking device for holding bulb in place when instrument is not in use. —*Weksler Thermometer Corp., 195 E. Merrick Rd., Freeport, L. I., N. Y.*



For more information circle **321** on inquiry card.

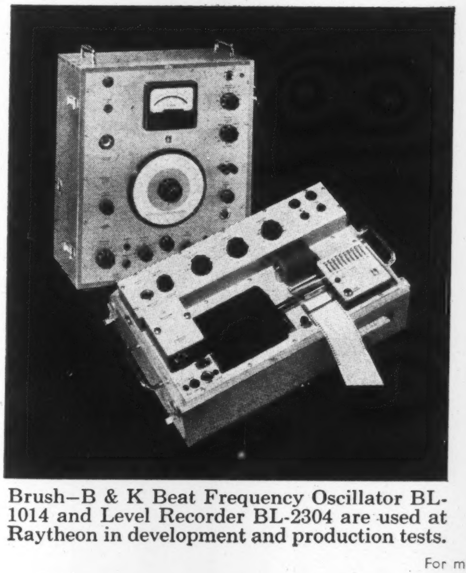
MINIATURE TC HEAD

New miniature screw-type connection head for thermocouples, electric heating elements, etc., is available in



BRUSH*... complete systems for noise or vibration measurement*

Records noise output of guided missile vacuum tubes



Brush–B & K Beat Frequency Oscillator BL-1014 and Level Recorder BL-2304 are used at Raytheon in development and production tests.

Electrical noise developed when a vacuum tube is subjected to mechanical shock and vibration affects missile performance—thus must be held within close limits to meet military requirements.

In this test setup, Raytheon Manufacturing Co. vibrates vacuum tubes by using a Brush–B & K beat frequency oscillator to supply a swept signal to a shaker table. Then a level recorder provides a chart of the tube noise output vs. frequency, at vibrations up to 5,000 cps, with accelerations up to 15G. Test results help to evaluate new designs, and aid in controlling noise output in production tubes.

This application of Brush – B & K equipment is typical of environmental testing by manufacturers and users of electronic components and complete assemblies. For a complete line of instrumentation to simplify your sound, vibration or strain measurements, call your Brush Representative now for application assistance or write for a brochure.

For complete information write Dept. A-8.

BRUSH ELECTRONICS BRUSH ELECTRONICS **COMPANY**
3405 Perkins Avenue, Cleveland 14, Ohio
DIVISION OF
CLEVITE CORPORATION

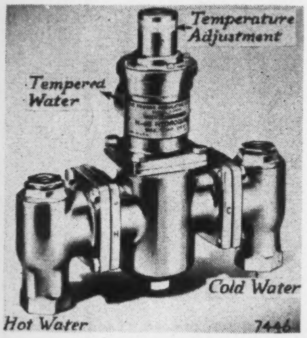
For more information circle **70** on inquiry card.

plain models or with angle bracket. Stem sizes adaptable to new connector head are $\frac{1}{16}$", ⅛", $\frac{3}{16}$" and ¼". These new sizes will provide a screw-type connection between small-gage TC wires and larger-gage lead wires. Stress and vibration of conductor are eliminated by transferring load to stem or bracket.—*The Marlin Mfg. Corp.* 12410 *Trisket Road, Cleveland* 11, *Ohio.*

For more information circle **322** on inquiry card.

THERMOSTATIC WATER MIXER

New "Type N Hydroguard" water temperature control features "triple-safety protection": shuts hot water port if cold water supply fails; closes cold water port if hot water supply fails; and closes hot and cold water poppets if thermal motor fails. Other unique features include rotating inlets and outlet which permit mixer to be installed in any position, and tamper-proof setting. Available in 65-115°F or 85-160°F range, in 45-gpm or 125 gpm capacities.—*Powers Regulator Co.*, 3434 *Oakton St., Skokie, Ill.*

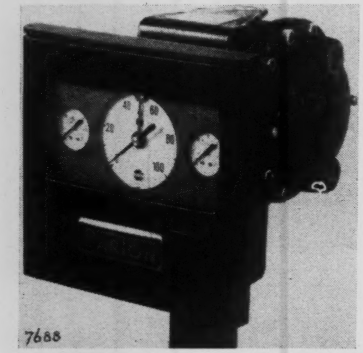


For more information circle **323** on inquiry card.

PRESSURE and VACUUM

D-P CONTROLLER

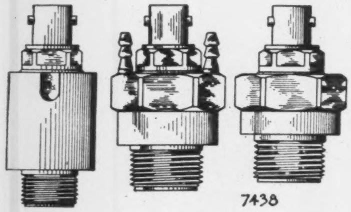
New "Model 237 Differential Pressure Controller" combines main features of maker's "Model 199 Rupture-Proof Bellows Unit" with U. S. Gauge "Pneumatic Pilot," is furnished in D-P ranges from 0-20" water to 0-50 psi with static pressure ratings to 6000 psi. Control actions furnished as standard include proportional with 1-150% adjustment, on-off and differential gap. Reset action is optional with adjustment from 0.1 to 5.0 minutes per repeat.—*Barton Instrument Corp.*, 1429 *S. Eastern Ave., Los Angeles* 22, *Calif.*



For more information circle **324** on inquiry card.

PRESSURE INSTRUMENTATION

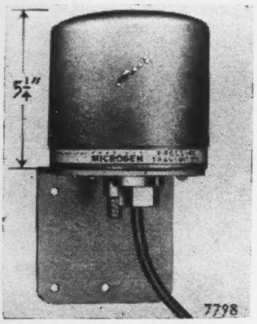
New "Model DG-400 Dynagage" replaces "DG-101 Dynagage" and "PS-102 Power Supply"; features simplified tuning and improved performance as well as 75% reduction in weight. Also announced are improved pressure pickups bringing total to forty-one, including pickups with water-cooled diaphragms, flush-diaphragm pickups, high-frequency pickups, etc., to meet all requirements of aircraft and auto engines, blast-pressures, high-level sounds, underwater research, etc.—*Photocon Research Products*, 421 *N. Foothill Blvd., Pasadena* 8, *Calif.*



For more information circle **325** on inquiry card.

PRESSURE TRANSMITTER

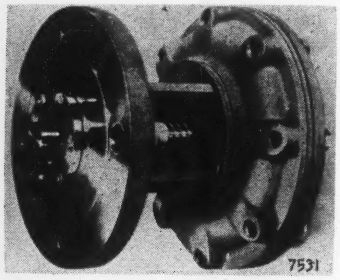
New "Series 185" miniaturized electronic pressure transmitter features printed circuitry, uses "Microsen Balance" whereby errors and effects of ambient conditions are eliminated by a unique electrical feedback system; incorporates improvements including size reduction, universal mounting, and cover threaded on base for dust- and weather-proofing. Sensitivity within 0.001% of range span, repeatability within 0.0002%, calibration accuracy within 0.5%. Available in all ranges from 0-15 psi to 0-20,000 psi.—*Manning, Maxwell & Moore, Inc., Stratford, Conn.*



For more information circle **326** on inquiry card.

PRESSURE TRANSMITTER

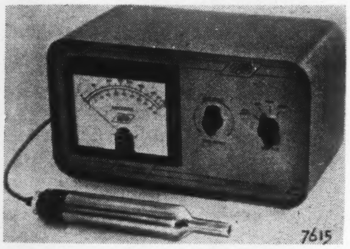
Newly redesigned "Model P" low cost pneumatic pressure transmitter is unique in that it utilizes simple flat diaphragms instead of bellows; operates on force-balance principle; is said to be ideal for services involving viscous substances, or materials which solidify in static lines of Bourdon tubes; has wide applications also for liquid level indication on open tanks containing viscous materials or those with solids in suspension.—*Conoflow Corp.*, 2100 *Arch Street, Philadelphia* 3, *Pa.*



For more information circle **327** on inquiry card.

HOT-WIRE VACUUM GAGE

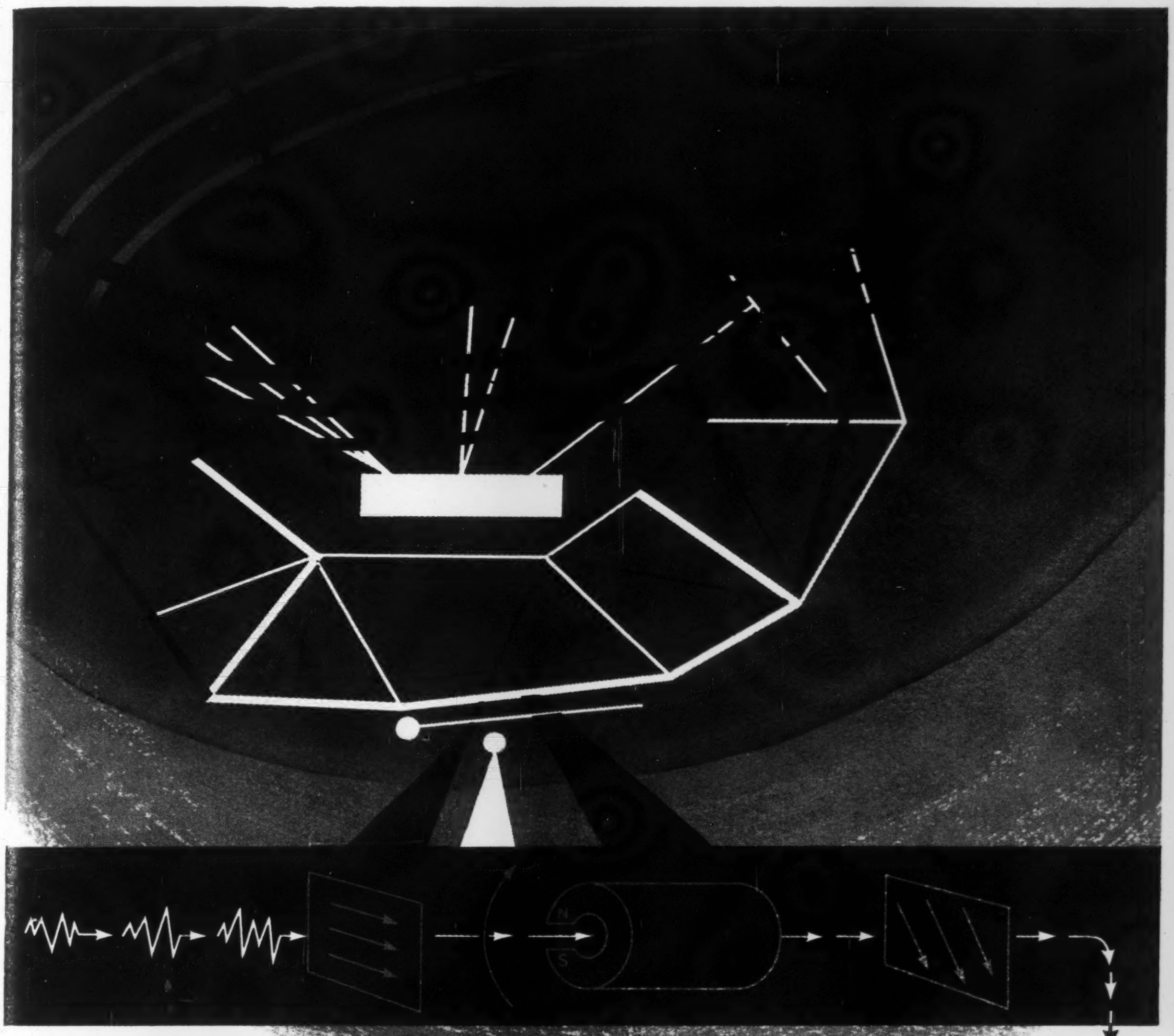
New "Type 2201-03" single-station Pirani-type gage gives direct continuous pressure readings from 1 to 2000 microns Hg; has two scales high-range 0-2000 microns with 50 microns lowest division; low scale expands 0-to-50-micron portion of upper scale and is calibrated in one-micron units. New sensing tube greatly reduces zero drift. Automatic voltage regulation facilitates operation and allows use of a recorder without constant attention.—*Rochester Div., Consolidated Electrodynamics Corp.*, 1775 *Mt. Read Blvd., Rochester, N. Y.*



For more information circle **328** on inquiry card.

DIAPHRAGM MANOMETER

New diaphragm manometer for measuring vacuum, pressure and differential pressure—where range does not exceed 4" of water and static



in radar load isolators, too

CRUCIBLE PERMANENT MAGNETS

give maximum energy. . . minimum size

Special applications, such as radar load isolators, demand compact but powerful magnet assemblies. And this is but one of the many places where the *consistently* higher energy product provided in Crucible Alnico magnets pays off.

These Crucible Alnico permanent magnets can be sand cast, shell molded, or investment cast to exact size, shape or tolerance requirements . . . and in any size from a mere fraction of an ounce to hundreds of pounds.

The design and production of permanent magnets has been a Crucible specialty ever since Alnico alloys were discovered. It's one of the good reasons why so many people bring their magnet applications to Crucible. Why don't you? *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

For more information circle **71** on inquiry card.

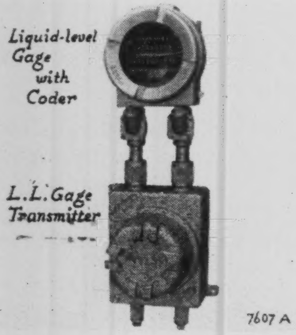
pressure is not over 5 psig—is designed to actuate maker's indicating, recording, or controlling instruments; comprises a large 302 stainless-steel convoluted diaphragm in an aluminum housing.—*Taylor Instrument Companies, Rochester* 1, *N. Y.*

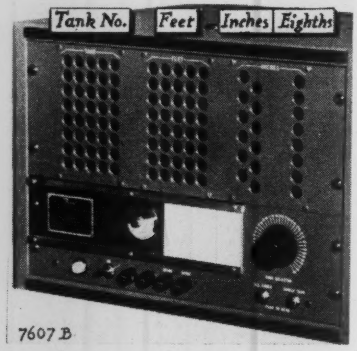
For more information circle **329** on inquiry card.

LIQUID LEVEL

TANK-GAGING SYSTEM

New "Electro-Span" digital tank gaging system measures liquid levels to 64 ft in tank farms over a single wire-pair; can read-and-hold or scan automatically. Average temperature can be transmitted. Cyclic timers can make readings at set times. Readings can be fed to electric typewriter or punched cards. Receivers can be set up in several locations.—*Bendix-Pacific,* 11600 *Sherman Way, North* Hol*lywood, Calif.*





For more information circle **330** on inquiry card.

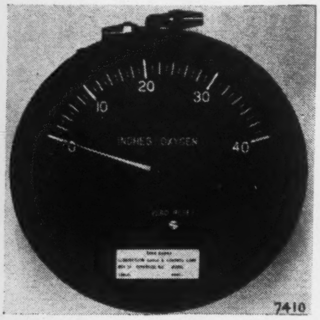
PLASTIC TUBULAR GUARD FOR TUBULAR GAGE

New Lucite tubular guards for protecting tubular gage glasses of liquid-level gages are designed to take the place of metal guard rods, offer greater safety and protection and better visibility. Plastic tube completely surrounds gage glass and protects it from breakage from the outside; prevents liquid from spraying on anyone if gage glass should rupture and break.—*Jerguson Gage & Valve Co.,* 80 *Fellsway, Somerville* 45, *Mass.*

For more information circle **331** on inquiry card.

MAGNETICALLY-COUPLED D-P OR L-L GAGE

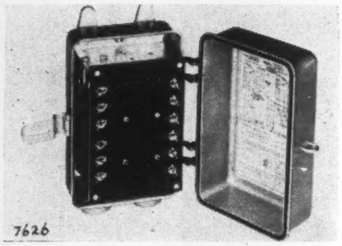
New differential pressure gage is especially adaptable for measuring contents of tanks containing oxygen and other liquefied gases. Pressure-responsive element is a bellows, its inside connected to liquid line while vapor line is connected to inside of bellows housing (outside of bellows). Motion of bellows is conveyed to pointer by means of a leak-proof magnetic coupling. New gage can be used on moving vehicles.—*Liquidvision Gauge & Control Corp., P.O. Box* 51, *Oceanside N. Y.*



For more information circle **332** on inquiry card.

LIQUID LEVEL CONTROLLER

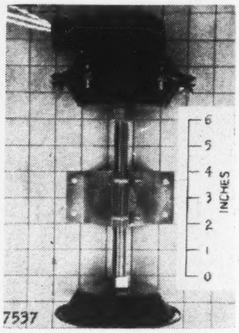
New "Type 10CB4" controls all electrically conductive liquids; is used with maker's probe type fittings; features flexibility of application and absence of moving parts in tank. Each instrument has four ranges of resistivity of probe circuit to match conductivity of liquid being controlled. Extremely low alternating voltage in probe circuit assures complete safety and eliminates problem of electrolysis.—*Photoswitch Div. Electronics Corp. of America,* 77 *Broadway, Cambridge* 42, *Mass.*



For more information circle **333** on inquiry card.

LIQUID LEVEL CONTROLLER

New "Cat. 140 Sensitive Liquid Level Control" features extreme sensitivity, made possible by use of a diaphragm operated by air pressure trapped in cup-shaped bowl immersed in liquid. Switch can be made to operate on a minimal liquid level height of ⅜" and to release when level is reduced by about 5/32". Connecting pipe, between switch elements and submerged bowl, can be fabricated to suit user's requirements.—*The Henry G. Dietz Co.,* 12-15 *Astoria Blvd., Long Island City* 2, *N. Y.*

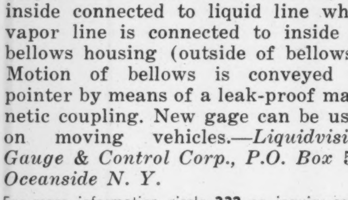


For more information circle **334** on inquiry card.

FORCE, LOAD, WEIGHT

SENSITIVE DYNAMOMETER

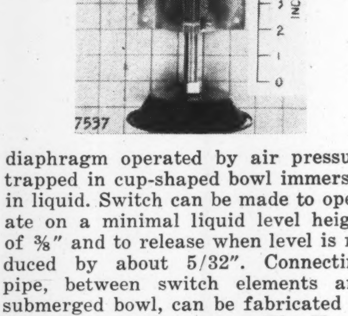
New "Gram Gage" having a range of 0.5 to 5 grams has been added to maker's line of spring tension gages, which now covers range from 0.5 g to 1 kg or equivalent in ounces.—*George Scherr Co., Inc.,* 200 *Lafayette St., New York* 12, *N. Y.*



For more information circle **335** on inquiry card.

FHP DYNAMOMETER

New "Model 1100" fractional-horsepower dynamometer is a dc unit, separately excited, suitable for operation

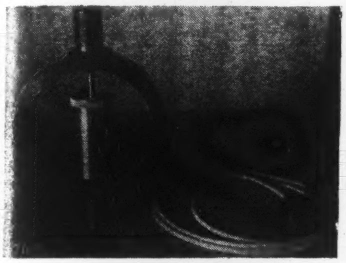


from a 125-volt power source. Control panel includes armature ammeter, armature voltmeter, "low-off-high" load switch and field rheostat. Two 660-watt resistor units are located on subbase for loading dynamometer as a generator. Larger resistor units can be used. Chatillon 10" scale is well-damped and preloaded to allow torque readings in either direction of rotation.—*The Standard Electric Time Co., Springfield, Mass.*

For more information circle **336** on inquiry card.

PROVING-RING FORCE PICKUP

New "Type TDC-4" proving-ring dynamometer, for measuring static or dynamic forces, utilizes maker's

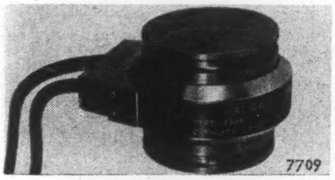


"Linear Variable Differential Transformer"; combines accuracy of proving ring as a force-to-deflection converter with accuracy of LVDT as a deflection-to-voltage converter and transmitter. Response is instantaneous, thus making it possible to measure and control a wide range of weights and forces. A convenient mechanical zero adjust is provided. Available in ranges from 0 to ±50 lb up to 0 to ± 10000 lb. Output variation is completely stepless. Full range output is about 0.25 v with 6.3-v 60-cps input.—*Schaevitz Engineering, P. O. Box 505, Camden 1, N. J.*

For more information circle **337** on inquiry card.

20,000-LB FORCE PICKUP

New "Type 9326 Load Cell," designed to measure high-frequency variations of thrust imparted by ex-

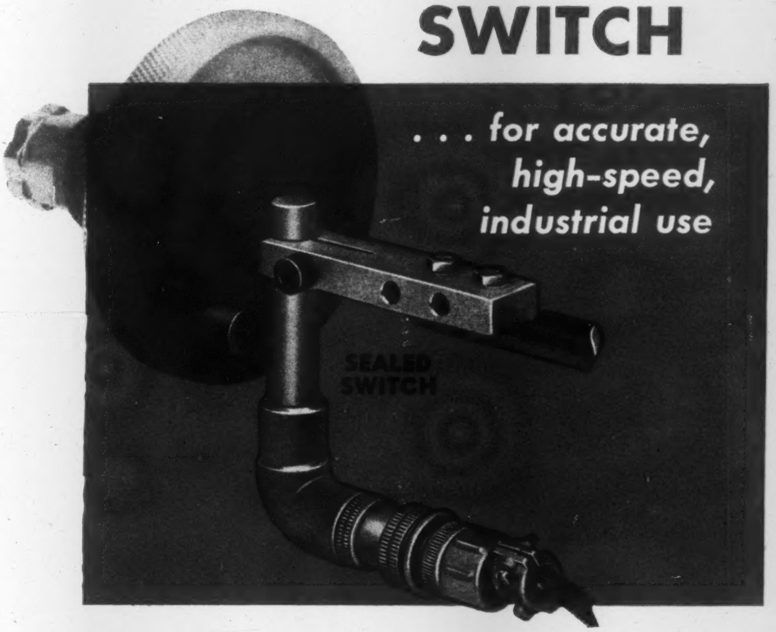


plosive reactions of solid-propellant rockets, is of 20,000-lb capacity; maximum deflection 0.0005" in. under full load; natural mechanical frequency response of about 1900 cps (more than twice that of any previous "Load Cells."—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **338** on inquiry card.

50,000-LB FORCE GAGE

New 50,000-lb model of maker's "Force Gauge" is suitable for testing applications hitherto impractical be-



POST *Decitron* **MAGNETIC SWITCH**

Positive 'sensing' from zero to 100 cycles per second

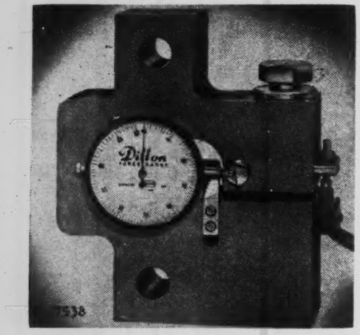
The Post model MH-2 is a magnetically operated high-speed switch which is controlled by the proximity of a magnetic field. When the magnet reaches the face of the sealed switch, there is a clean 'make', or contact, and as the magnet moves away, a positive 'break' occurs. No lag . . . no jumping.

Unique in operation, the MH-2 works fully as well at low speeds. For example, a clearly defined 'make' and 'break' is possible at any speed range from zero up to 100 cycles per second. The MH-2 has a 'life' of over 30 billion cycles.

Post's MH-2 is an ideal sensing device for actuating electronic and mechanical counters, controls, solenoids, relays, and other electrical and electronic circuits. Write Post for descriptive literature "M" today.

POST
Electronic Products Division
POST MACHINERY CO.
Elliott Street—Dept. M Beverly, Massachusetts

For more information circle **72** on inquiry card.

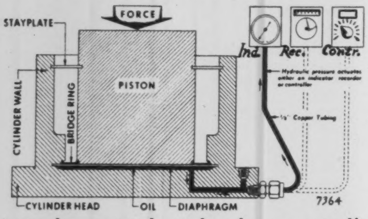


cause of high range required; is available for either compressive or tensile tests; guaranteed accuracy within 1%. Model pictured is tensile version, with eyes for insertion of clevises. Compression model has instead a recessed cup on top for seating a free-riding hardened steel ball.—*W. C. Dillon & Co., Inc.,* 14620 *Keswick St., Van Nuys, Calif.*

For more information circle **339** on inquiry card.

WEIGHING SYSTEMS

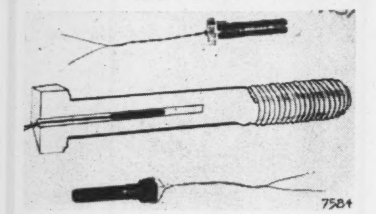
New "EC" weighing systems are said to feature outstanding capacity to operate successfully under extremely rugged and adverse conditions—not only bin and conveyer uses but measurement of jet engine thrust, dynamometer power measurement, etc. Systems can be used to command control mechanisms for automatic operations.—*The A. H. Emery Co., Pine St., New Canaan, Conn.*



For more information circle **340** on inquiry card.

LOAD-SENSITIVE SCREWS, BOLTS, AND RODS

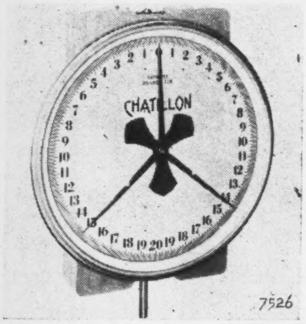
New primary load-measuring elements feature a special resistance type strain gage potted in a small axial hole. Wire leads are brought out through head of measuring element. Elongations are measured directly with standard strain-measuring instruments. High accuracy is easily attainable. Maker will supply screws, bolts, or rods with gages; will apply gages to user's special screws or rods. —*Polyphase Instrument Co.,* 701 *Haverford Rd., Bryn Mawr, Pa.*



For more information circle **341** on inquiry card.

TWO-WAY DYNAMOMETERS

New "Push Pull Dynamometers" are the only scales which permit measuring push and pull from the same shaft; can be mounted vertically or horizontally. Ten models with capacities from 1 to 500 lbs.—*John Chatillon & Sons, New York* 38, *N. Y.*



For more information circle **342** on inquiry card.

DISPLACEMENT, VIBRATION, SHOCK, etc.

ACCELERATION-SENSITIVE SWITCH

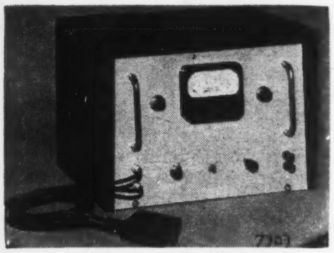
New acceleration-sensitive switch has a snap-acting switch element set precisely, in manufacture, to open or close at desired *G* level from 2.5 to 15 *G* (higher on special order). Two basic styles: (1) momentary-contact; (2) manually reset. Models with integral time-delay are also available. Switches are rated at 30 v 1 amp inductive or 2 amp resistive load; frequency range 0 to 10 cps; shock resistance 25 *G* for 11 milliseconds, on all three axes.—*W. L. Maxson Corp.,* 47-37 *Austell Place, Long Island City* 1, *N. Y.*

Maxson Instruments

For more information circle **343** on inquiry card.

VIBRATION CALIBRATOR

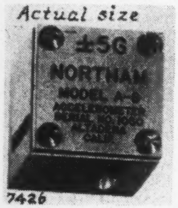
New "Model 501" calibrates vibration pick-ups or measures vibration of non-magnetic metallic surfaces;



utilizes a novel method of self-calibration whereby vibratory displacements are compared with a precise standard displacement; requires no direct contact with vibrating surface; measures amplitude over four decade scale ranges from 0.00002" to 0.0[illegible]" full-scale (readings independent of frequency from 10 to 20,000 cps).—*ACF Electronics,* 800 *North Pitt St., Alexandria, Virginia.*

For more information circle **344** on inquiry card.

ACCELERATION PICKUP

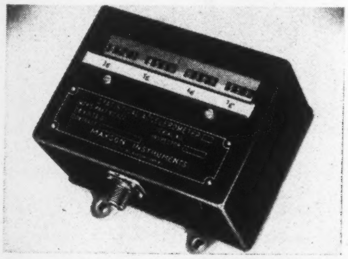


New "Model A-8" miniature acceleration pickup, of variable-reluctance type, features dynamic characteristics which allow measurement of accelerations from static to vibration frequencies as high as 1000 cps for the 300-G unit. Available in ranges from ±5 to ±300 *G* (higher and lower ranges on special order); weight 1 oz; size ¾" cube; output 40 mv/v full-scale; accuracy better than 1% under constant ambient conditions.—*North American Instruments, Inc.,* 2420 *North Lake Ave., Altadena, Calif.*

For more information circle **345** on inquiry card.

SHOCK RECORDER

New "Statistical Accelerometer" counts the number of times pre-selected *G* levels are equalled or exceeded. Typical use: recording shocks experienced in shipping delicate apparatus. It comprises a group of acceleration-sensitive switches, built to make contact at predetermined levels and directions of acceleration, and a set of four-digit magnetic counters. Instrument can be furnished in four-channel or five-channel style. Each channel can be factory-set to count at



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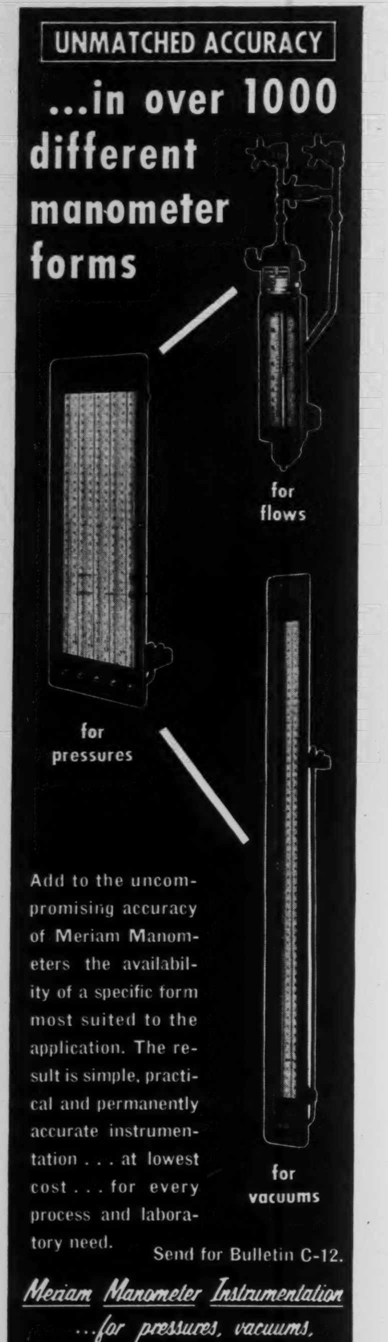
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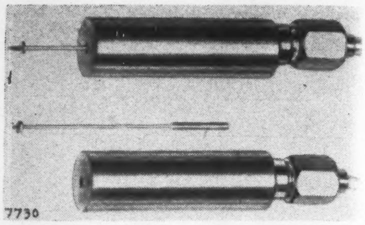
For more information circle **74** on inqiury card.

any level from 2.5 to 10 *G* absolute, in increments of 0.5 *G* minimum.—*W. L. Maxson Corp., 47-37 Austell Place, Long Island City* 1, *N. Y.*

For more information circle **346** on inquiry card.

DISPLACEMENT PICKUP

New "submersible" type of variable-permeance pickup will operate completely submerged in liquid under pressure; will measure position, displacement or vibration. Housing is an all-welded assembly, and connecting leads are conducted out of immersion area through tubing which attaches to an AN fitting welded to housing.

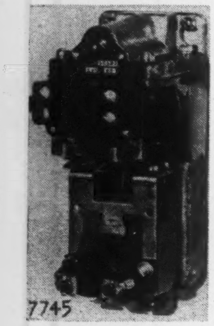

7730

All material exposed to liquid is stainless steel. Linear ranges from 0.2" to 164" are available. Various models will work in ambient temperatures from −160°F to 1300°F.—*Crescent Engineering & Research Co.,* 11632 *McBean St., El Monte, Calif.*

For more information circle **347** on inquiry card

TIME, SPEED, COUNT

AUTOMATIC TIMER

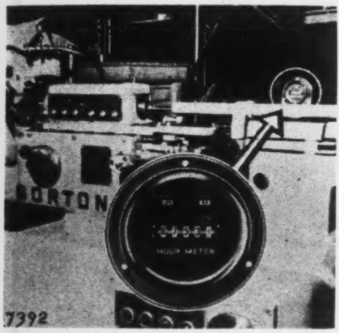

7745

New pneumatic timer for use in automatic control circuits such as machine-tool sequencing, process control, etc., is designed for heavy-duty applications; has a time delay of 0.2 sec to 180 sec; accuracy 10% of setting. A "G-E Strongbox" coil on magnet structure sharply reduces coil failure by excluding dirt and moisture, and protects windings from slipping screwdrivers and other mechanical damage. All terminals accessible from front. —*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **348** on inquiry card.

TIME METERS

New hour meters for 120, 240 and 480 vac, 25, 50 and 60 cps., are available in 10,000-hour models (showing 1/10 hours) and in 100,000-hour models. Mechanism is sealed against dust, moisture, etc., is powered by a synchronous motor. —*John W. Hobbs Corp., Springfield, Ill.*



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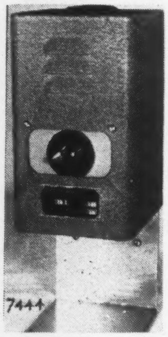
For more information circle **349** on inquiry card.

AUTOMATIC TIMERS

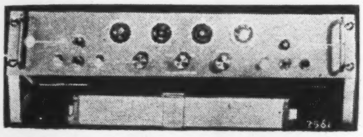

7444

Two new general-purpose electronic timers, "TA-1," housed for mounting in the open, and "TA-2," chassis model for use with other electrical equipment, are each available in ranges of 0.05 to 1 sec or 0.05 to 10 sec; operate without warmup; feature voltage regulation to insure repetitive accuracy. "Time control adjustor" scale (calibrated for 0 to 100) reads approximately in percentage of timer's full range. Remote adjustment is effected by removing this "adjustor" from timer chassis.—*Post Machinery Co., Beverly, Mass.*

For more information circle **350** on inquiry card.

TIME COUNTER

New "Model 210 Digital Timer" four-decade electronic counting instrument for rack-mounting or portable use can be used as an electronic counter at rates as high as 60,000 cps. Time is indicated, in units of 100 or 1000 usec (10 usec increments optional on later models). Time is registered by counting pulses generated by an internal 100-kc crystal-controlled oscillator, for an interval determined by externally-applied start and stop impulses. Each timing cycle is initiated by momentarily pressing an internal or external reset button. Period measurements are made by paralleling both inputs. Optional equipment comprises a mechanical register

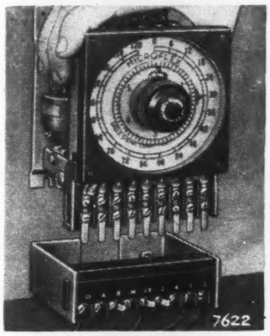

7561

for extended range, or a dc gate control amplifier for added versatility.—*Hupp Instrumation, 2119 Sepulveda Blvd., Los Angeles 25, Calif.*

For more information circle **351** on inquiry card.

RESET TIMER

New improved "HA4 Series" of maker's "Microflex" synchronous-motor-driven reset timer trips its three

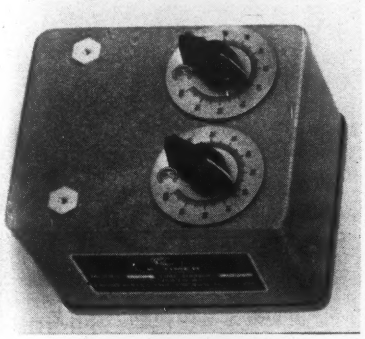

7622

sets of contacts closed or open after an adjustable time interval. Starting and resetting are electrically controlled. Accuracy 1/60th second on a [illegible]0-second dial. Over 100 timer operating combinations are available. Timers are available for time ranges from 0.3 second to 120 hours.—*Eagle Signal Corp., Moline, Ill.*

For more information circle **352** on inquiry card.

RECYCLING TIMER

New "Model 3CK" electronic timer is fully enclosed; has independently adjustable ON and OFF ranges of 1.5,



3, 6, and 12 seconds (standard); can easily be converted to a single time-cycle operation by removing one tube; has 8-amp sp-dt contacts for 115 vac operation (25 to 400 cps).—*Farmer Electric Products Co., Inc., 2300 Washington St., Newton Lower Falls, Mass.*

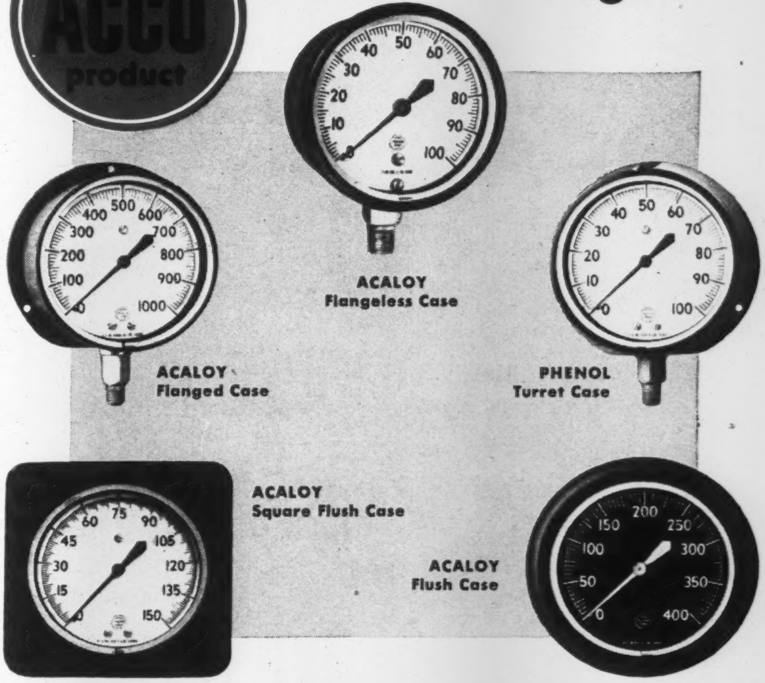
For more information circle **353** on inquiry card.

MULTI-CIRCUIT TIMERS

New low-cost multi-circuit repeat-cycle timers and interval timers are made only to individuals' specifications; utilize maker's standard "Circle B" synchronous timing motor and snap-action enclosed switches rated at

an ACCO product

Helicoid Gages



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No expense has been spared in extensive research, engineering and testing equipment to produce this outstanding pressure instrument—a gage of the utmost precision and enduring accuracy.

HELICOID Gages are available for practically every type of installation and service—in many sizes and many styles—for pressure, vacuum or compound service. Furnished in a full range of pressures; all with the HELICOID stainless steel movement.

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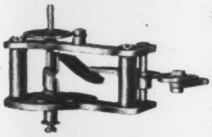

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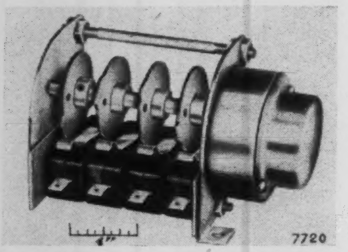
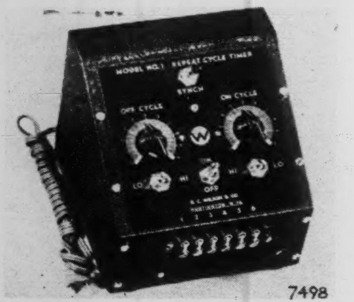


15 amp 125 vac; are available in various switch combinations and in cam speeds from 1 rev/sec to 1 rev/month. *—Bristol Motor Div., Vocaline Co. of America, Inc., Old Saybrook, Conn.*

For more information circle **354** on inquiry card.

REPEAT CYCLE TIMER

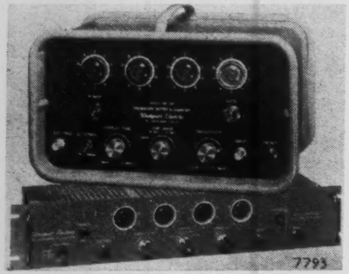
New improved version of maker's "Model 1" fully-enclosed repeat cycle electronic timer providing adjustable time intervals from 0.1 to 200 seconds features repeatability of 1% or better under normal operating conditions.*—G. C. Wilson & Co.,* 1915 *Eighth Ave., Huntington, W. Va.*



For more information circle **355** on inquiry card.

FREQUENCY COUNTER

New "WE-130 Frequency Meter and Counter," using glow transfer decade tubes, is available in portable or rack-mounted models. Its all-electronic feature permits start of counting interval to be determined by an external signal, also gives convenience of continuously-variable display time (0.5—5.0 sec and manual). Time bases are 0.1 and 1.0 sec; frequency range of four decades is 0-50,000 cps. *—Westport Electric,* 149 *Lomita St., El Segundo, Calif.*



For more information circle **356** on inquiry card.

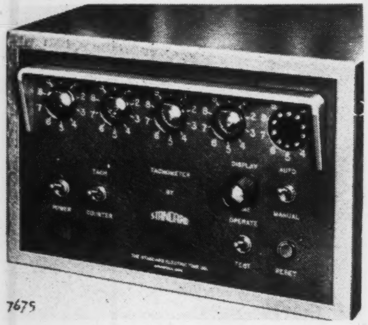
HYDRAULIC GOVERNOR

New "Class 3300" hydraulic governor, features full work capacity with complete regulation over full range of speed settings for constant-speed governors. Its rated work is 123 inch-pounds, and rated torque is 159 pounds-inches. Steady-state stability is better than 0.1%: isochronous or speed-droop characteristics are obtainable by manual adjustment.*—Farris Pickering Governor Co., Inc.,* 610 *Commercial Ave., Palisades Park, N. J.*

For more information circle **357** on inquiry card.

ELECTRONIC TACHOMETER

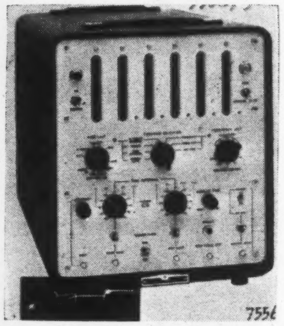
New "Model ETC" is said to combine accuracy of electronic counting and time measurement with "a new concept of design that makes the unit serviceable by unskilled personnel": package-type plug-in assembly permits replacement of any or all of nine separate electronic components in only a few minutes. In operation, "Model ETC" counts rpm, rate or frequency by counting electrical pulses for an accurately-timed interval. Count is displayed directly on glow counter tubes and is accurate to one count. (For rpm, 60-tooth gear is attached to part whose speed is measured.) "Model ETC" reports pulses from 10 to 50,000 per second*—Standard Electric Time Co., Springfield* 2, *Mass.*



For more information circle **358** on inquiry card.

FREQUENCY, PERIOD AND TIME COUNTER

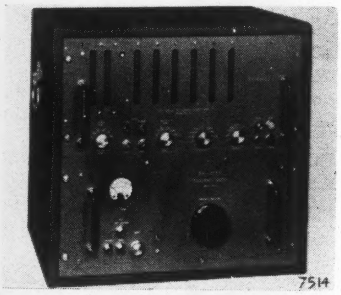
New "Model 523B" multipurpose electronic counter measures frequencies from 10 cps to 1.1 Mc, periods from 0.00001 cps to 10 kc, and time intervals from 3 usec to 27.8 hours; reads directly in seconds, milliseconds, microseconds, or kilocycles. Accuracy of frequency measurement is ±1 count ± crystal stability of 2 parts per million per week. Special puls output permits Z-axis modulation o a CRO to display time-interval star and stop points on an input waveforn (shown in figure as bright spots o input signal). Wide selection of gating and display times or manual control. Automatic illuminated decima point.*—Hewlett-Packard Co.,* 27 *Page Mill Rd., Palo Alto, Calif.*



For more information circle **359** on inquiry carc

FREQUENCY AND TIME INSTRUMENTATION

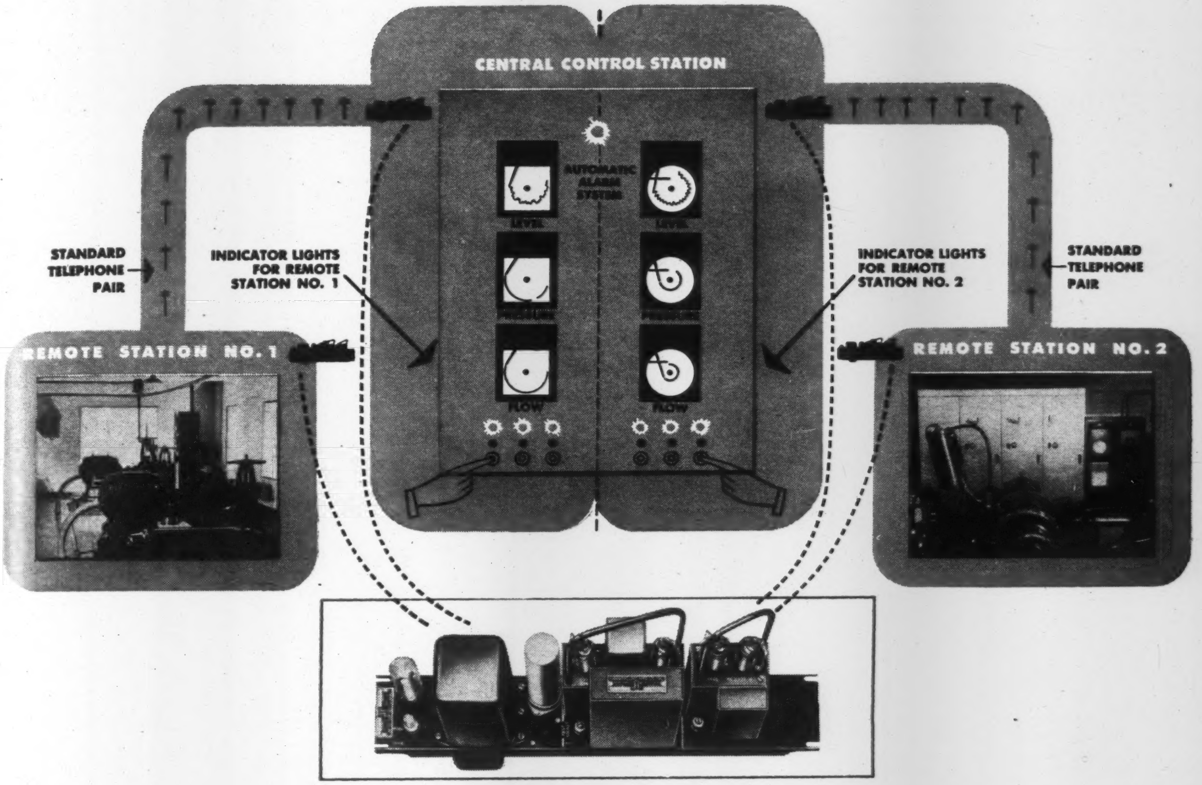
New "Model 5571 Frequency Meter" permits direct digital frequency readings from 1 cps to 42 Mc; functions also as a frequency ratio meter, 0-1 Mc period meter, microsecond to 10-million second time-interval meter, 0-2 Mc events-per-unit-time meter, and high-speed straightforward counter. ★New "Model 5580 Converter" multiplies by 12 the frequency meter's range to 515 Mc, with accuracy to 1 part in 10^7 ±1 cycle. ★ "Model 5581 Plug-In Units" cover 13 fixed bands from 42 to 515 Mc; eliminate bulk and high cost of wide-band amplifiers; consist of mixers and multipliers for generating precise references or base frequencies from crystal-controlled frequency produced by the converter. *—Dept.* 2843, *Berkeley Div., Beckman Instruments, Inc.,* 2200 *Wright Ave., Richmond* 3, *Calif.*



For more information circle **360** on inquiry card.

PRESET COUNTER

New "Model 7240 A Preset Counter" provides reliability inherent in simplified circuitry by utilizing recently-developed cold-cathode glow transfer tubes which accomplish both counting and indication. It counts and indicates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PRESSURE
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STANDARD TELEPHONE PAIR
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REMOTE STATION NO. 1
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Hammarlund COC equipment accomplishes reliable supervision of your entire water system from a single, central control location. It relieves operating personnel to perform more important work in maintaining high quality service to your customers.

Hammarlund COC equipment is rapidly becoming the key to economy with more and more water and sewage systems throughout the country. COC equipment costs are low. In most cases an installation will pay for itself in less than two years. It can be used with your present instruments, utilizing a standard telephone pair between points in the system with many functions being supervised, controlled, or telemetered simultaneously on a single pair of lines.

With the installation of a Hammarlund COC system you can supervise and record flow, pressure and level at all stations. In addition, by means of a central control board, you can start and stop pumps, proportionally open and close valves, or perform any other function directly from the central station usually requiring visits by personnel to outlying stations.

Versatility of the COC system is practically unlimited. Any number of stations can be covered, regardless of distance, while any number of measuring or control functions can be handled. The design of the Hammarlund COC system permits expansion at any future date without complications or re-engineering of the existing system. If need arises for radio-link communications between units, instead of a standard telephone pair, it may easily be accomplished utilizing the original equipment.

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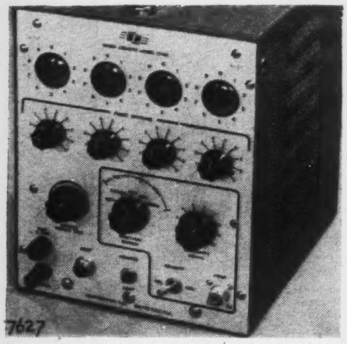


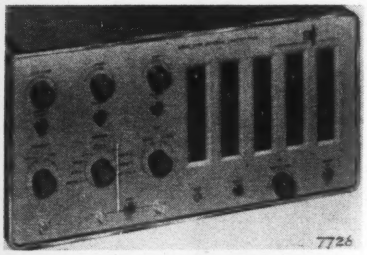
input events up to a number (from 1 to 9,999) preset by four decade switches, at which time an output pulse is provided, a relay operates, and count is held. Rapid recycling or manual resetting to repeat operation is provided. It can be used also as a time interval generator by counting line-voltage frequency, presenting interval as a relay open or closed time.—*Electro-Pulse, Inc.*, 11861 *Teale St., Culver City, Calif.*

For more information circle **361** on inquiry card.

FREQUENCY COUNTER-TIMER

New "Model 225A Universal Counter-Timer" has been designed for pre- gasket is furnished to assure dust- cise measurement of frequency, frequency ratios, period, average period and time interval. With appropriate pickups it can be utilized for measuring process variables, acceleration, displacement, etc.; also serves as a secondary frequency standard. Among features: three direct-coupled inputs, quick time base alignment, 70-mv sensitivity, provision for 'scope marker signals for trigger level adjustment on complex wave forms.—*Computer-Measurements Corp.*, 5528 *Vineland Ave., N. Hollywood, Calif.*

For more information circle **362** on inquiry card.



ELECTRIC COUNTER

New panel-mount "PIC-600" electric counter is reset by a key from front of panel. A 1/32" thick neoprene gasket is furnished to assure dust-tight seal. Available for 60, 40-50, 25 cps and dc, all standard voltages to 150.—*Production Instrument Co.*, 710-20 *W. Jackson Blvd., Chicago* 4, *Ill.*

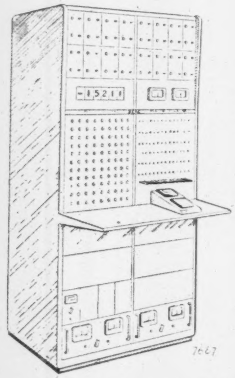
For more information circle **363** on inquiry card.

COMPUTING and DATA PROCESSING

ALGEBRAIC COMPUTER

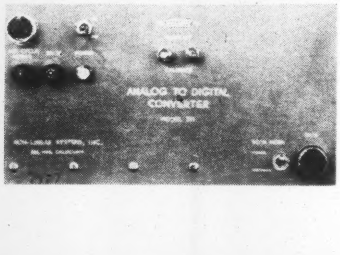
New modification of maker's "REAC 400" makes possible solution of linear algebraic equations and of problems in linear programming; can obtain solutions to as many as fifteen simultaneous linear algebraic equations; can solve problems in linear programming involving up to fifteen unknowns, evaluate determinants or any of their minors or form the product of two or more matrices. A special version can accept the output from a mass spectrograph and provide direct instantaneous read-out of chemical component distributions. Output voltages are developed by individually stabilized, drift-free amplifiers of type used in "REAC" computers.—*Reeves Instrument Corp.*, 215 *E.* 91*st St., New York* 28, *N. Y.*

For more information circle **364** on inquiry card.



LOW-VOLTAGE DIGITIZING CONVERTER

New "Model 311 Analog to Digital Converter" digitizes the outputs of low-voltage pickups in aircraft and ground equipment at rate of 20 measurements per second. It measures direct voltages with resolution of 12½ microvolts by means of a digital scan-



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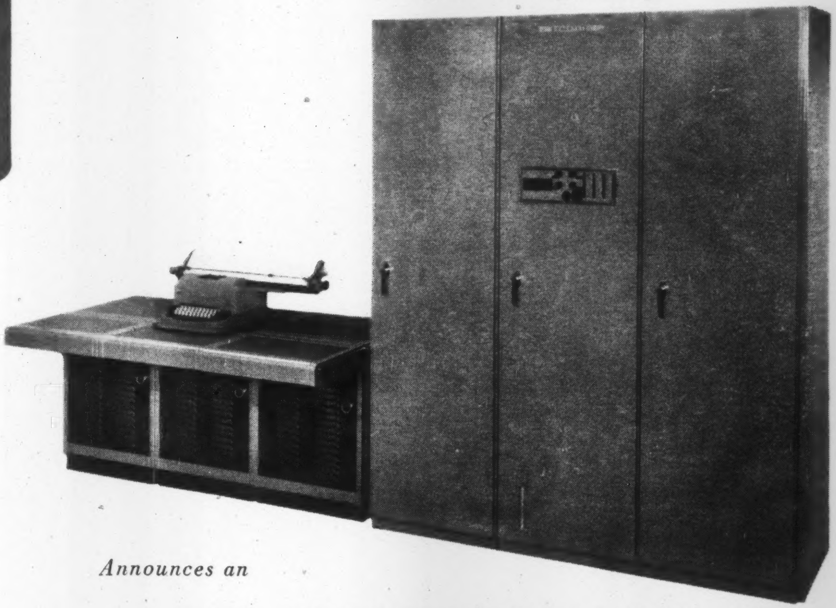

Qualified persons are invited to view this equipment at our New York Laboratory during the week of the I.S.A. Show. Write or call for further information.

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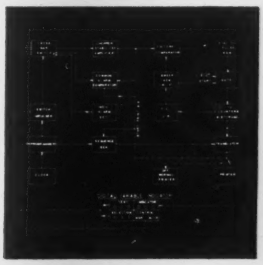

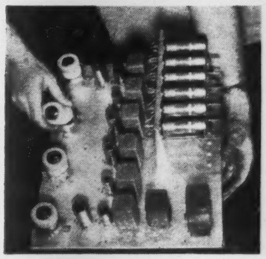

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For more information circle **78** on inquiry card.

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Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior. • 6" clear reading chart; various standard ranges from minus 40°F. to plus 550°F. • 3 standard types; choice of 24-hr. or 7-day cycle. • Electric or mechanical chart drive. • With capillary tubing for remote reading. Priced from $49.50.

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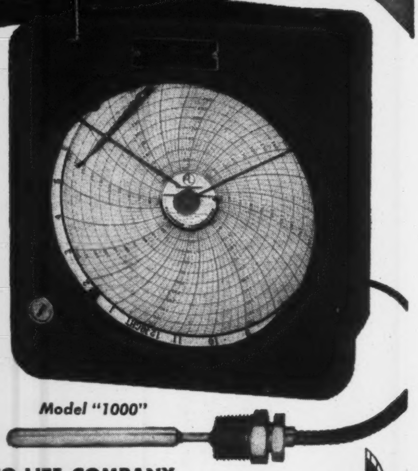

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TEMPERATURE RECORDERS

For more information circle 79 on inquiry card.

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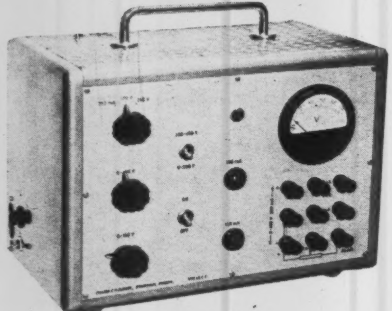

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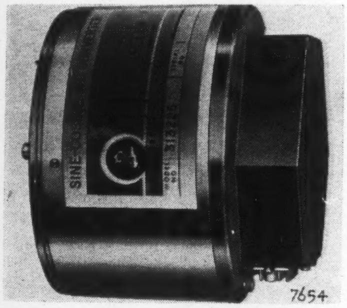
For more information circle 80 on inquiry card.

ning technique. Unknown voltage is compared with standard reference voltage through use of twelve digital scanning units; a thirteenth indicates polarity. All scanning units are modular and interchangeable. Counting speed is 400 steps per second. At end of each measurement, "Model 311" provides a relay closure to trigger recorder (accessory coded readout also can be connected to display each measurement visually up to 999). A "Scan Mode" switch selects form of readout: visual or automatic.—*Non-Linear Systems Inc., Del Mar Airport, Del Mar, Calif.*

For more information circle **365** on inquiry card.

SINE-COSINE AN-DIG

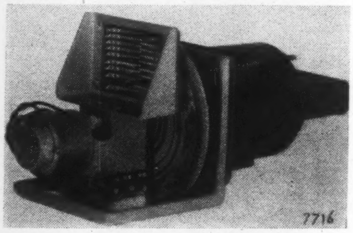
New "Eight-Bit Sine-Cosine Analog to Digital Converter," about 4" OD by 3½" L, comprises two disc-type commutators with pick-off brushes; uses double-brush V-scan system to avoid ambiguity. Input shaft is scaled at 360° per rev full-scale input. No intermediate gearing needed. Continuous serial binary coding; each quadrant is divided into 257 parts, each part representing equal values of functions. Sine and cosine values simultaneously available.—*Librascope, Inc., Glendale 1, Calif.*



For more information circle **366** on inquiry card.

AN-DIG CONVERTER FOR TELEMETERING

New inexpensive analog-to-digital converter is for accurate long-distance transmission of data representing voltage, current and power. (Conversion of power, in particular, to any form suitable for transmission has presented problems: equipment has been expensive and results subject to drift, temperature and voltage errors.) Converter is of photo scanner type, using a conventional pointer-



type measuring instrument without modification of movement or loading of the output shaft. A small motor rotates a photocell-light assembly and code disc. As light and photocell rotate, light beam is reflected to photocell by mirror except when measuring-instrument pointer blocks light. When this happens, a sensitive relay drops out and a battery of digit storage relays reads code disc position. These relays hold this code until a new code is determined; storage relays then can be called upon for a parallel or serial digital transmission of reading. —*Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood, Calif.*

For more information circle **367** on inquiry card.

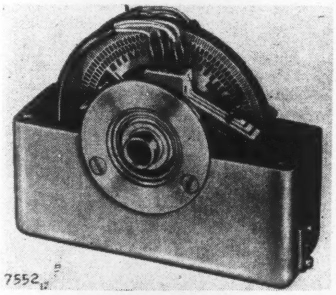
ROTARY SWITCHES

New rotary segmented switches and drums, for use in analog-to-digital converters, shaft-position-to-digital converters, etc., have a wide variety of applications. Drums are available in unambiguous natural binary, cyclical binary, binary coded decimal, and gray code. All other outputs, codes, or arbitrary linear or logarithmic functions are feasible. Metal segments are diamond-turned absolutely flush with plastic. Units are much smaller than corresponding pancake types.—*Airflyte Electronics Co., 535 Avenue A, Bayonne, N. J.*

For more information circle **363** on inquiry card.

SHAFT-POSITION ENCODER

New low-inertia shaft-position encoder designed specifically for use in high-speed servo systems utilizes a unique method of construction that results in lowering inertia reflected into servo driving system from 423 gm-cm^2 to 235 gm-cm^2. It provides an angular resolution of 0.3° or better (1000 counts in 360° or less),



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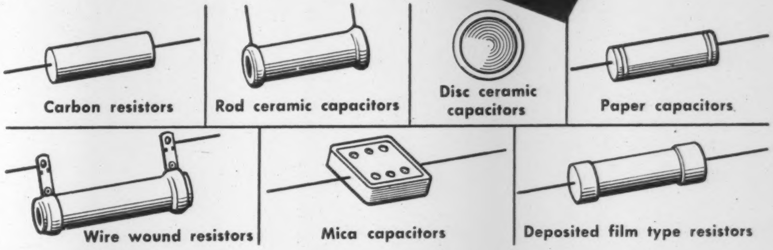

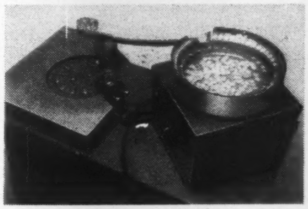

Jigging designs available to accommodate practically any electronic component to be tested and sorted by the Auto-Bridge. Application shown is sorting disc ceramic capacitors.

An automatic device for high-speed testing and sorting of components. Used by leading manufacturers of components for final testing as well as stage-by-stage inspection. Also used extensively for incoming inspection by component users. Tests for go—no go or grouping into as many as 8 percentage tolerances by merely flicking a switch. Tests resistors, capacitors, inductors or impedance elements. Accuracy is ±0.3% in the range from 10 ohms to 5 megohms in impedance. Equipment may be used at resistances above 5 megohms. Speed of operation is entirely dependent upon components to be tested and type of jigging ordered.

Write for complete information on the Auto-Bridge today.

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For more information circle **81** on inquiry card.

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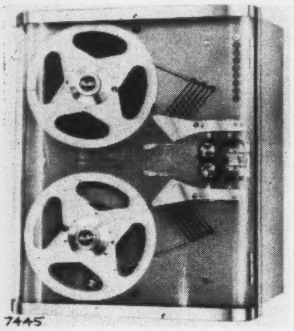
and can be mounted directly on servo shaft.—*G. M. Giannini & Co., Inc.*, 918 *E. Green St., Pasadena* 1, *Calif.*

For more information circle **369** on inquiry card.

MAG-TAPE HANDLERS

New "905 Series" of digital magnetic tape handlers feature fast rewind in both forward and reverse directions; tape speeds up to 75 ips with 3-millisecond starts and stops; accommodate tape widths from ¼" to 1¼". Transport mechanism is mounted on hinged panel for immediate access to all mechanical parts and tubes.—*Potter Instrument Co., Inc.*, 115 *Cutter Mill Rd., Great Neck, N. Y.*



For more information circle **370** on inquiry card.

PRINTOUT SYSTEM FOR DIGITAL INDICATORS

New printout system for maker's digital instruments features readings which appear numerically on a continuous paper tape and can be programmed to print at any desired interval. Readout is from Clary printer of three columns with space for additional columns for program code or time indication. Specialized information from the new unit can also be printed on punchcard or pen-type recorders. Printout code is available in decimal, binary coded decimal or binary code. Accuracies of 0.01% to 1% can be maintained on full-scale dc readings; ac accuracies to 2%. —*Hycon Electronics, Inc.*, 321 *S. Arroyo Parkway, Pasadena, Calif.*

For more information circle **371** on inquiry card.

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DIGITAL DATA RECORDER

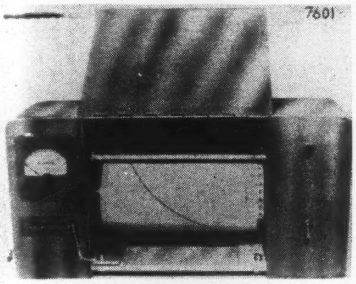
New "Electrotyper Model F" modified IBM typewriter operates in conjunction with maker's "Keypak" re-

mote keyboard, is particularly applicable to photopanel or similar numerical information to be visually read and tabulated. Advantages: increased accuracy and tabulation speed by direct tabulation; direct tabulation on standard forms; reproducible masters in excess of 10 copies obtainable; suitability for use in partly illuminated rooms using projection equipment and increased economy of operation.—*Benson-Lehner Corp.*, 11930 *Olympic Blvd., West Los Angeles* 64, *Calif.*

For more information circle **372** on inquiry card.

CURVE FOLLOWER

New "SF-1 Curve Follower" accepts as input any curve $y=f(x)$ drawn with conducting ink on 8½" x

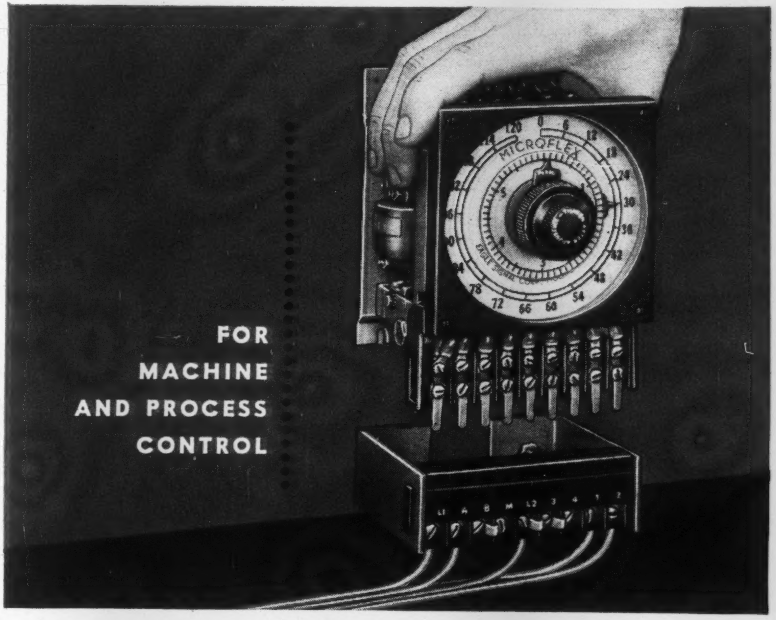


11" paper. A rotating linear resistance element across which is impressed a reference voltage is made to continuously contact the curve, thereby producing a time-varying voltage (up to 200 v if desired) proportional at any instant to curve's ordinate, accurate to within 0.5% of full-scale. Risetime from zero to full-scale is less than 0.1 usec and overshoot is zero. Since device does not depend upon a servo positioning device it cannot "lose" the curve and produce erroneous signals. Any speed range up to 10 ips can be furnished in both single and multiple-channel units.—*Alabama Automation Corp., Times Bldg., Huntsville, Ala.*

For more information circle **373** on inquiry card.

DIGITAL READOUT UNIT

New digital readout unit is unusually versatile; features shuttle carriage that permits a serial readout of up to ten digits of identification information and up to ten digits of in-



EAGLE

Microflex Reset Timer

NOW . . . quick plug-in connection!

See that new-design terminal panel? Terminals are all in a row. So you can quickly and easily adapt the Microflex Reset Timer to plug-in connection. Simply use a Microflex Plug-In Kit, available in all accepted variations. You can even rotate the terminal panel for rear connection — (just loosen two screws) — without any rewiring.

Time settings of pinpoint accuracy are possible with the Microflex double dial. Through precision vernier action, one complete turn of the *inner* dial advances the *outer* dial just one division. That's a 20-to-1 ratio, made possible by a patented Microflex threaded axle and pinion. Accuracies are obtainable to 1/60 second. Over 150 timer operating combinations, plus a wide range of long or short time periods. The ideal timer for molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

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COMPANY

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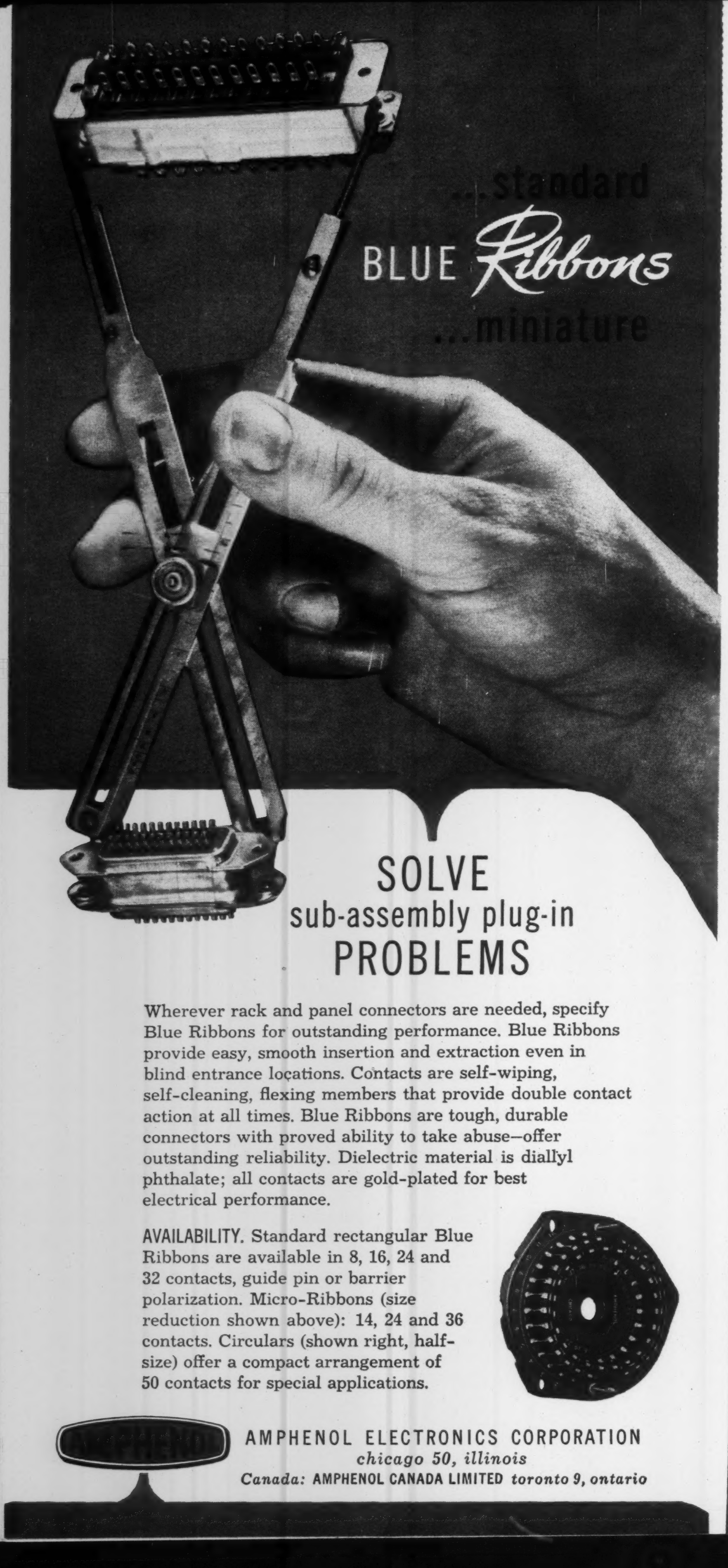
CITY ZONE STATE

For more information circle **82** on inquiry card.

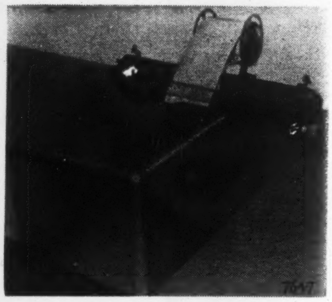


SOLVE
sub-assembly plug-in
PROBLEMS

Wherever rack and panel connectors are needed, specify Blue Ribbons for outstanding performance. Blue Ribbons provide easy, smooth insertion and extraction even in blind entrance locations. Contacts are self-wiping, self-cleaning, flexing members that provide double contact action at all times. Blue Ribbons are tough, durable connectors with proved ability to take abuse—offer outstanding reliability. Dielectric material is diallyl phthalate; all contacts are gold-plated for best electrical performance.

AVAILABILITY. Standard rectangular Blue Ribbons are available in 8, 16, 24 and 32 contacts, guide pin or barrier polarization. Micro-Ribbons (size reduction shown above): 14, 24 and 36 contacts. Circulars (shown right, half-size) offer a compact arrangement of 50 contacts for special applications.

AMPHENOL ELECTRONICS CORPORATION
chicago 50, illinois
Canada: AMPHENOL CANADA LIMITED *toronto 9, ontario*

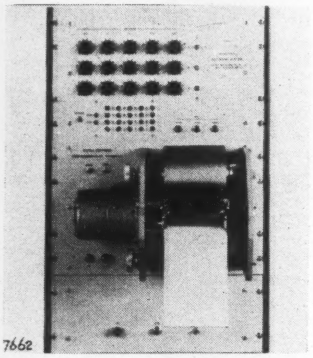


put data in individual columns on same line; can be programmed to add (to eleven digits), subtract, sub-total, total, list only an a non-add basis, and has credit balance feature as a standard item. Carriage is 12½" wide; automatically shuttles between two columns.—*Industrial Electronic Engineers, 3973 Lankershim Blvd, North Hollywood, Calif.*

For more information circle **374** on inquiry card.

DIGITAL DATA RECORDER

New "Model 3151" automatically-sequenced digital recorder, described as "very-high-speed," simultaneously

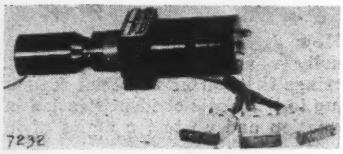


records "on" or "off" voltages on as many as 45 channels at sampling rates as high as 2,500 per second, in the form of black marks for "on" channels (positive voltage input of +1 volt or more) and no marks for "off" channels (no signal input) on electrosensitive "Teledeltos" recording paper. Paper speed over 150 ips (about 1/16" spacing for 2.5-kc sampling rate); more than 3,500,000 record locations on a single 400-ft roll.—*Potter Instrument Co., Inc., 115 CutterMill Rd., Great Neck, N. Y.*

For more information circle **375** on inquiry card.

SAMPLING SWITCH

New miniature motor-driven sampling switch has 20, 30, 40, or 45 contacts per pole, one to four or more



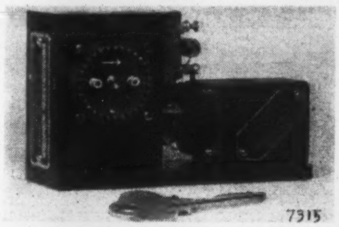
← Circle **83** on inquiry card.

poles. Motor can be dc, or 60- or 400-cps ac. Convenient cables and plugs, one plug per pole. "Perma Brush" constant-force wiper mechanism affords service-free life of 500 hours minimum or total life of thousands of hours.—*General Devices, Inc., P. O. Box 253, Princeton, N. J.*

For more information circle **376** on inquiry card.

MINIATURE SAMPLING SWITCH

New line of small lightweight ro- ary sampling switches with integral c drive motor features phasing be- ween poles manually adjustable while n operation. Available with 1, 2, 3, or 4 poles containing 24, 30 or 32 shorting (12, 15, or 16 non-shorting) contacts per pole; sampling speeds from 0.1 to 10 rps.—*Applied Science Corp., P. O. Box 44, Princeton, N. J.*

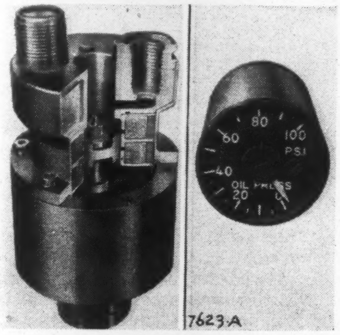


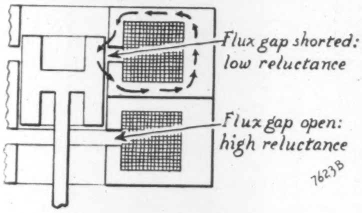
For more information circle **377** on inquiry card.

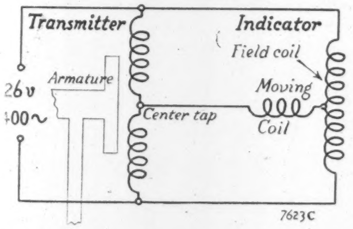
FOR AIRCRAFT AND MISSILES

AIRCRAFT ENGINE PRESSURE INDICATING SYSTEM

New transmitter and remote indi- ator for oil-pressure indication are aid to be "different from all other systems produced up to this time" and to make it possible "for the first time to mount the transmitter directly on he engine without shock or vibration solators." System maintains 1% in- rinsic accuracy at vibrations up to 00 cps, temperatures to 232°C 450°F) and shock to 20 *G*. Indicator s a 2" OD sealed ratiometer.—*Instru- ent Div., Thomas A. Edison, Inc., Vest Orange, N. J.*




Flux gap shorted: low reluctance
Flux gap open: high reluctance
7623B



or more information circle **378** on inquiry card.

ACCELERATION PICKUP

AMERICAN GYRO
7351

New "Model A-10 Linear Accelerometer" for guided missiles weighs 0.8 lb; operates exactly at altitudes from sea level to 90,000 ft; has working range of 0 to 50 *G*; can be connected in series with gyroscopes. Shock capability ± 15 *G* 18 times in three directions, 11 milliseconds duration.—*Daystrom Pacific Corp; American Gyro Div., 3030 Nebraska Ave., Santa Monica, Calif.*

For more information circle **379** on inquiry card.

ACCELERATION INDICATOR

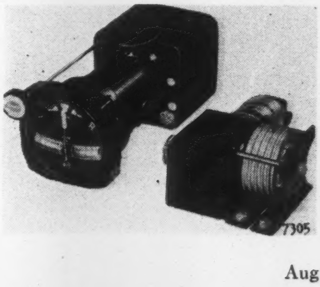
4
6
2
8
0
10
2
ACCELERATION UNITS
7214

New three-pointer accelerometer indicator has a range of −5 to +10 *G* units and indicates vertical accelerations when plane of mounting lugs is vertical; is built to MIL-A-5885A and withstands basic environmental tests. —*Burton Mfg. Co., Colorado Ave. at 26th St., Santa Monica, Calif.*

For more information circle **380** on inquiry card.

AUTOPILOT

New "Dart I" low-cost single-axis autopilot featuring design simplicity and said to offer "unusually smooth performance on light and medium aircraft" controls direction and rate



BARBER COLMAN **tach generators**

for accurate speed indications and rate control applications

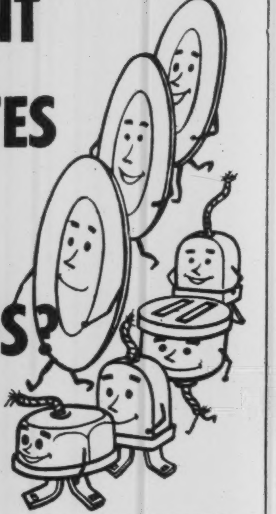
up to 40 volts per 1000 rpm within plus or minus 0.5% linearity over the operating range with very low slot and commutator ripple. Barber-Colman tach generators are available in three different frame sizes with maximum rated outputs up to 7000 rpm or 100 volts, whichever occurs first. Typical applications include controlling antiskid circuits for wheel braking . . . surface control systems of guided missiles . . . indication of film speed rate in aerial cameras . . . and rpm indication of variable speed drives in industrial machines, processing equipment and similar production units. Many variations of Barber-Colman tach generators are available for special applications. Send for free technical bulletin.

The complete line of Barber-Colman d-c motors

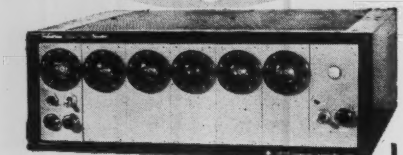
. . . includes both permanent magnet and split series types . . . in various mountings and speeds with outputs up to 1/10 hp. Ideally suited to power electro-mechanical actuators, switches, and programming devices. Also available with gearheads or blowers for special applications. Whatever your problem involving small d-c motors, let Barber-Colman Company engineers help you find the solution. Write for free Catalog F-4344-3.

Barber-Colman Company
Dept. H, 1415 Rock Street, Rockford, Illinois
For more information circle **84** on inquiry card.

COUNT PLATES OR PLUGS?



use an **ATOMIC** totalizer or pre-set counter for complete control



Atomic produces the widest variety of standard counting models available . . . decade or duodecade types . . . speeds up to 2000 c.p.s. for controllers, 20,000 c.p.s. for totalizers . . . single or dual preset counters, totalizers with up to 8-digit capacity provide real versatility for production control.

Functional Plug-in Strips, used in Atomic's equipment, provide complete instruments for specialized requirements . . . eliminating costly "custom-design" charges. Strip construction, using low-current, low-heat glow transfer tubes simplifies circuitry . . . provides thousands of hours of reliable, trouble-free operation.

Plug-in replacement of strips eliminates costly downtime . . . keeps equipment operating at full production.

If your plant methods include unit counting, controlling output by preset totals or measuring linear or liquid flow, you'll find interesting reading in Atomic's new Counting and Control Systems Catalog — for your copy ask for Catalog B-30.

Visit Booths 1319-1320
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BAIRD ATOMIC

Baird Associates–Atomic Instrument Co.

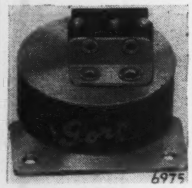
33 University Road
Cambridge 38, Mass., U.S.A.

For more information circle **85** on inquiry card.

of turn; comprises a turn-sensing unit and an actuator connected by a single cable. Installations are CAA approved for most popular light aircraft.—*Air Associates Aviation Supplies Div; Teterboro, N. J.*

For more information circle **381** on inquiry card.

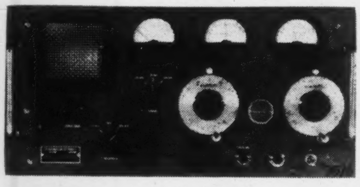
ALTITUDE SWITCH



New "Model GB-300 Miniature Barometric Pressure Switch" permits automatic control of aircraft electric or electronic circuits under all temperature and altitude conditions; can be set to open or close a circuit at any altitude from 1000 to 50,000 ft; weighs less than 2 oz.—*Gorn Electric Co., Inc., Stamford, Conn.*

For more information circle **382** on inquiry card.

TELEMETERING RECEIVER

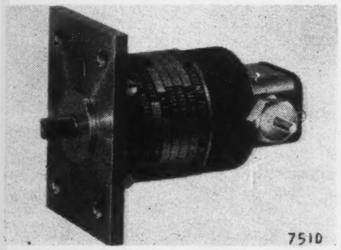


New "Type 1400" crystal-controlled double-conversion telemetry receiver operates in frequency range of 216 to 245 Mc and a choice of two different IF bandwidths of 500 kc or 100 kc can be made from front panel by means of a selector switch.—*Nems-Clarke, Inc., 919 Jesup-Blair Drive., Silver Springs, Md.*

For more information circle **383** on inquiry card.

P-M TACHOMETER GENERATORS

New tachometer generators are adapted from maker's line of type BYLM permanent-magnet motors.

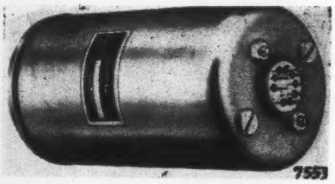


Three frame sizes are available with maximum rated outputs of 7000 rpm or 100 volts, whichever occurs first. Output voltages up to 40 v per 1000 rpm; 0.5% linearity over operating range.—*Aircraft Controls Div., Barber-Colman Co., 1400 Rock St., Rockford, Illinois.*

For more information circle **384** on inquiry card.

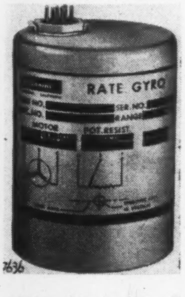
RATE GYRO

New rate gyro weighs 1.7 lb; was designed for low-cost production, but is extremely rugged. Motor is dc-powered and governor-controlled so that output is independent of line voltage. Standard units incorporate damping dashpot and adjustable switches which can be set to close at desired rate.—*Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.*



For more information circle **385** on inquiry card.

RATE GYRO

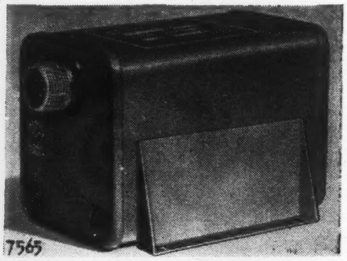


New "Model 36129" oil-filled rate gyro incorporates a non-heated temperature-sensitive mechanism to maintain a linear damping over the ambient temperature range of −54°C to 71°C; provides rate signals up to 70 v with a linearity of 1.5% or better and repeatability of 0.4%. High-level output needs no amplification in dc telemetering or instrumentation applications; no demodulation is required for most ac control systems.—*G. M. Giannini & Co. Inc. 918 E. Green St., Pasadena 1, Calif.*

For more information circle **386** on inquiry card.

MISSILE AND AIRCRAFT INSTRUMENT 5-VDC SUPPLY

New "Stablvolt MRP-5-1S" dual-magnetic-regulated airborne power source provides a transient-free 5 vdc up to 1 amp for missile and aircraft instrumention. A Cannon "2306-55" connector permits unit to carry 115 vac at 60,000 ft. Magnetic flux oscillator circuitry isolates line voltage transients from output and regulates dc to 0.1% accuracy.—*Magnetic Research Corp., 200-202 Center St., El Segundo, Calif.*



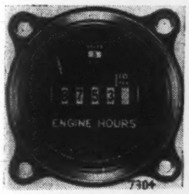
For more information circle **387** on inquiry card.

OMNIRANGE INDICATOR

New variable omnirange indicator (VOR) of advanced design is said to be "the only such instrument in the field which uses d'Arsonval self-shielding core movement."—*Avionics Div., Simpson Electric Co.,* 5200 *W. Kinzie St., Chicago* 44, *Ill.*

For more information circle **388** on inquiry card.

AIRCRAFT HOUR METERS

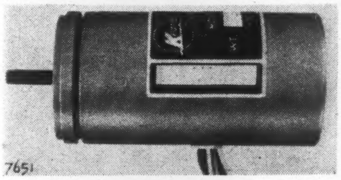


New "Hobbs" engine and flight hour meters are direct-reading. Engine Hour meter is installed with a pressure switch in engine oil line. Flight Hour Meter is installed with an air switch. Both are sealed against dust and moisture in Bakelite cases; are regularly furnished with an electric brake feature that assures split-second timing. Case diameter 2 15/64"—*Air Associates, Teterboro, N. J.*

For more information circle **389** on inquiry card.

SERVOMOTOR-GENERATOR

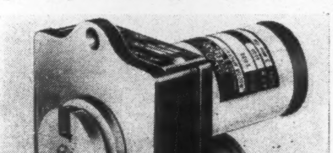
New "Type R809" size 11 servomotor-generator for airborne servo systems features all stainless steel construction, small size (2⅛" L), light weight (6 oz) and operating temperature range from −54°C to 125°C; delivers 0.6 oz-in torque at stall; no-load speed 5600 rpm. Models are available with both low and high impedance windings and a center tap is provided for parallel operation in push-pull circuits. Generator output is 0.5 v per 1000 rpm and 19 mv at 0 rpm.—*Kearfott Co., Inc., Little Falls, N. J.*



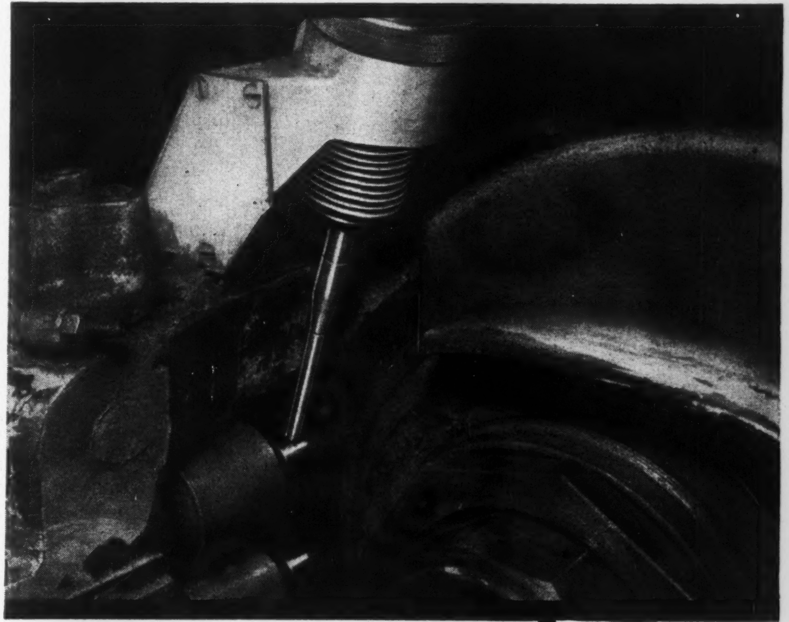
For more information circle **390** on inquiry card.

ROTARY ACTUATORS

New "R-4100 26VDC Series" rotary actuators feature compact design, high output and light weight. Rated



For grinding to 6 micron tolerances
automatically



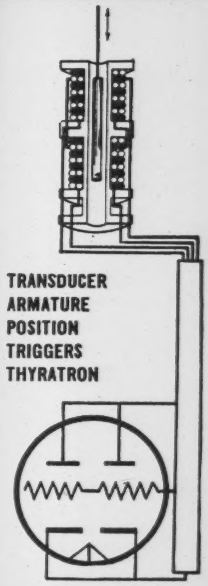
ATCOTRAN PRECISION SWITCH
. . . actuating force only 0.01 gram
. . . no overtravel problem

Designers are finding that automatic positioning and gauging operations are extremely simple, accurate, and trouble free when Atcotran Precision Switches are used for dimensional control.

The automatic control of grinding roller bearings to precision diameters, illustrated above, integrates the gauging and production operations to speed the process, improve uniformity and eliminate inspection. Similarly, countless operations in positioning, gauging, weighing, and displacement are being effectively controlled by Atcotran.

The electronic relay actuates two single-pole, double throw relays. These operate on opposite sides of a null position that can be adjusted to a tolerance of .0001 inch in transducer armature motion. The circuit utilizes a thyratron tube for positive control action. No special power supply required.

Investigate the advantages of applying Atcotran Precision Switches to your requirements.



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For more information circle **86** on inquiry card.

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PLUG-INS

Every day more organizations are discovering the advantages of using EECO plug-in circuits in developing electronic equipment. Why not join this winners' circle and prove the advantages for yourself?

❀ Your engineers will be free to concentrate on the design of systems instead of routine circuit detail.

❀ Your technicians can cut fabrication time and step up production by wiring sockets instead of circuits.

❀ Your customers will enjoy the satisfaction of superior equipment, the convenience of easier maintenance.

All of which adds up to greater profits, increased customer prestige, and more orders for you.

Standard EECO plug-ins, proven by more than four years' service in some of the nation's largest data systems, are available from stock. Custom units can be readily manufactured to your circuit requirements. Costs are actually below those of standard assembly methods. Write for data file No. A-3.

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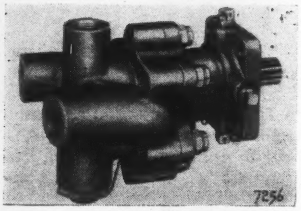
For more information circle **87** on inquiry card.

at 36 lb-in. max. and 3 rpm with magnetic brake and adjustable limit switches for up to 120° rotation; weight 10 oz; dimensions 2 x 2⅞ x 3 in. Thermal protection optional. Meets MIL-A-8064.—*Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J.*

For more information circle **391** on inquiry card.

AIRCRAFT OIL PUMP



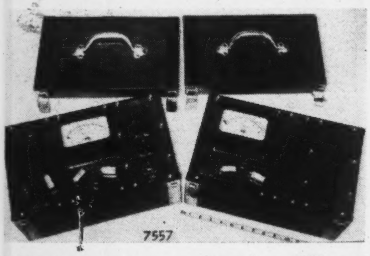
7256

New "Model RG-15000" rotary-gear positive-displacement hydraulic oil pump, designed for pumping MIL-O-5606 hydraulic fluid, features design which prevents cavitation and turbulence to pumping area. Rated capacity 3 gpm at 4500 rpm and 1000 psi discharge, pumping MIL-O-5606 at 100° F and 14-16 psia inlet pressure. Power required is 3.5 hp.—*Lear-Romec Div., Lear, Inc., Elyria, Ohio.*

For more information circle **392** on inquiry card.

GEOPHYSICAL PROSPECTING

LIGHTWEIGHT GEOPHYSICAL RESISTIVITY SYSTEM

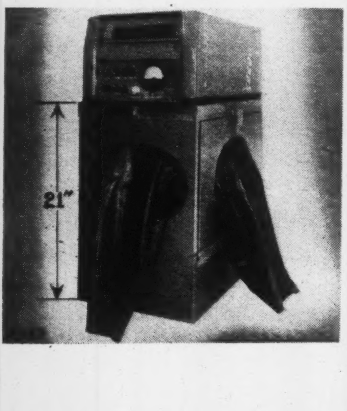


7557

New Resistivity System provides a fast and economical means of prospecting for mineral deposits and geological structures; comprises "Signal Generator Bank" which provides a 10-cps square-wave voltage applied to the two outer (current) electrodes of four equidistant electrodes; and "Voltmeter Bank" connected to the two inner (potential) electrodes. Units weigh less than 25 lb each.—*Houston Technical Labs., 2424 Branard St., Houston 6, Texas.*

For more information circle **393** on inquiry card.

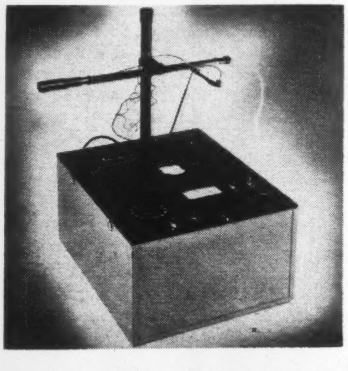
SEISMIC OSCILLOGRAPH



New "RS-8U All-purpose" seismic recording oscillograph operates with all seismic recording techniques: high-, conventional-, or low-frequency seismic recording, or use with magnetic recorder. Paper speed is changed with a flip of a switch and can be varied further by resetting governor. Light intensity changes automatically with paper speed. Fifty 500-cps ⅛"-dia galvanometers are standard, but 200-cps galvanometers can be specified. Timing-line accuracy is 1 part in 10,000. Camera sits atop a stainless-steel developing unit which obviates need for darkroom. "RS-8U" uses either 6" or 8" paper in 200-ft rolls.—*Houston Technical Labs., 2424 Branard St., Houston 6, Texas.*

For more information circle **394** on inquiry card.

GRAVITY-SURVEY-DATA ANALOG COMPUTER



New "Gravity Anomaly Simulator" simulates the effect on the earth's gravity field of a subsurface body of anomalous density. It is a new type of instrument, useful in interpreting data obtained when prospecting for petroleum and minerals with gravity meters. It makes it possible to prepare gravity data in hours that would require days by previous calculating methods.—*Houston Technical Labs., 2424 Branard St., Houston 6, Texas.*

For more information circle **395** on inquiry card.

NUCLEONICS

SCINTILLATION DETECTOR

New "P-20B," advanced version of "P-20 Series" scintillation detector, features a new flat-face photomultiplier tube designed specifically for scintillation counting; also interchangeable crystals which permit detector's use for counting alpha, beta and gamma radiation.—*Tracerlab, Inc., 130 High St., Boston, Mass.*

or more information circle **396** on inquiry card.

SCINTILLATION CRYSTALS

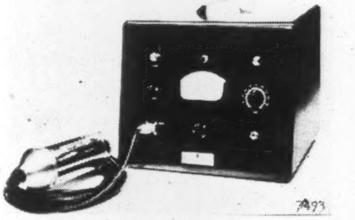
7372

New method of growing and mounting thallium-activated sodium iodide crystals produces high spectrometry grade and survey grade. These crystals are preferred for detection of gamma rays and for other purposes in nucleonics.—*Fretco Inc., 406 North raig St., Pittsburgh 13, Pa.*

or more information circle **397** on inquiry card.

SCINTILLATION COUNTER

New "#522" transistorized portable scintillation counter with external probes for use in small labs, hospitals, at bedsides, etc., operates either from ac line or from four built-in nickel cadmium batteries which are automatically recharged when unit is plugged into line.—*Universal Atomics Corp., 19 E. 48th St., ew York 17, N. Y.*

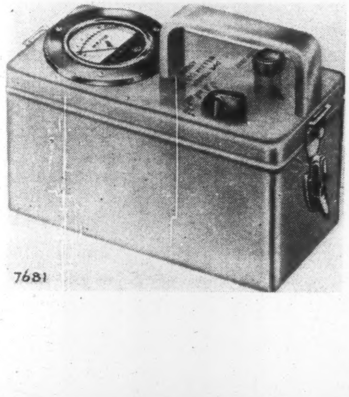


7493

or more information circle **398** on inquiry card.

SURVEY METER

New "Model 640" low-energy survey meter differs from all other commercial models in that it will measure ow-energy x-rays, low intensity x-

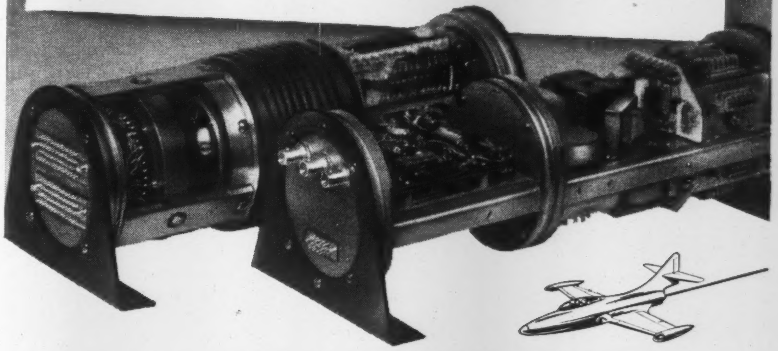


7681

NEW FROM ASCOP

Low Level PW Multicoders

Open a Whole New Field of Mobile Instrumentation!



Announcing a ***NEW*** *Line of*

SUPERSENSITIVE PW AIRBORNE EQUIPMENT

For Remote Measurement, Recording, Transmission

The new ASCOP D Series PW Multicoders provide, for the first time, supersensitive, low-level remote measurement of data from airborne vehicles. The extremely high input sensitivity, fast sampling rate, and wide selection of data channels (up to 88) of these new Multicoders . . . together with their critical accuracy, ultra-high altitude pressurization, and rugged design . . . suit them ideally to today's most important testing and prototype applications involving recovery and repeat use.

Provides A Complete Data System

The new ASCOP Multicoder, combined with ASCOP M Series Ground Station Equipment and suitable transmission or recording equipment, constitutes a complete data handling system that is easy to operate, flexible in application and provides simplified real time reduction. ASCOP also produces a complete line of PW Data Systems and equipment, Telemetering sets and High and Low Speed Rotary Sampling Switches. Contact ASCOP regarding your present program *today.*

FEATURES

- Operation from Standard Transducers and Pickups.
- Operation from Low-level Transducers.
- Recording and transmission of up to 88 data channels.
- Ease of data reduction.
- Pressurized for very high altitudes

SPECIFICATIONS

- **Input Sensitivity:** 0-15 mv
- **Input Circuit:** Differential balanced to ground
- **Data Channels:** 43 or 88
- **Sampling Rate:** 20 or 10 samples per second per channel
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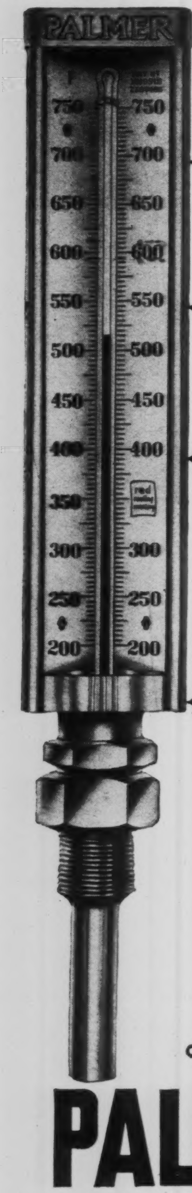

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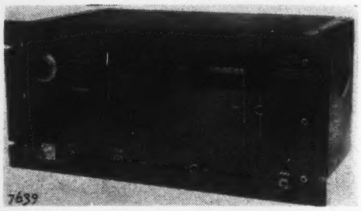
rays, beta rays, beta and gamma rays in the presence of an intense radiofrequency field; is especially needed where high-voltage equipment is in use; has three sensitivity ranges of 10, 100, or 1000 mr/hr; two energy ranges of 8 to 50 kev with mylar window and 50-2000 kev with cover plate.—*Victoreen Instrument Co., 3800 Perkins Ave., Cleveland, Ohio.*

For more information circle **399** on inquiry card.

SCALER & DISCRIMINATOR


7639

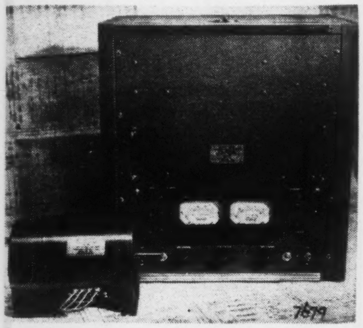
New "N-201" scale-256 high-speed scaler for scintillation counter application is patterned after a P.R. Bell design. Discriminator section has a speed compatible with scaler's unusually small dead time. Maker's "Vari-Flex Chassis" for relay-rack mounting or table-top use.—*Hamner Electronics Co., Inc., Box 531, Princeton, N. J.*

For more information circle **400** on inquiry card

SHOP EQUIPMENT and SUPPLIES

AUTOMATIC CONTROL SYSTEM

New automatic control system permits a multiple series of operations to be programmed on tape or punched cards for completely automatic operation of machine tools. Special motor (developed by Industrial Controls Corp.) provides such precise and rapid operation that it is fully applicable for instrumentation uses as well. This unique motor and its special amplifier eliminate much complex equipment (reducing number of vacuum tubes from 400 to 20). It is said that "for the first time, a new unit is now available for industrial applications with the combined ability to control displacement precisely and produce the power to do so. This is the first system which provides a simple means for eliminating hunting." —*The Teller Co., Butler, Pa.*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For more information circle **401** on inquiry card.

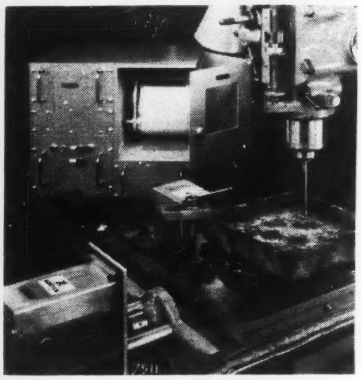
EPOXY EMBEDDING RESINS

New "Randac" epoxy resin systems, now available commercially, have been tested in hundreds of different electrical and electronic applications in military and civilian fields. Three main types: "R-4060" casting or embedding resin (rigid type); "R-4059" C or E (semi-flexible type); and "R-4053" hot-melt dip coating and sealing resins.—*Mitchell-Rand Insulation Co., Inc., 50 Murray St., New York 7, N. Y.*

For more information circle **402** on inquiry card.

AUTOMATIC POSITIONER

New light-weight low-cost "Binotrol" automatic positioning table, for repetitive runs in light manufacturing and small machine shops, controls a 10" x 10" "Master Model 12" table which is positioned in two axes to an accuracy of 0.001". Control console weighs under 60 lbs. Table can be used in combination with a drilling machine, miller, etc. Entire sequence of operations is permanently preserved on the tape.—*Barnes Engineering Co., Stamford, Conn.*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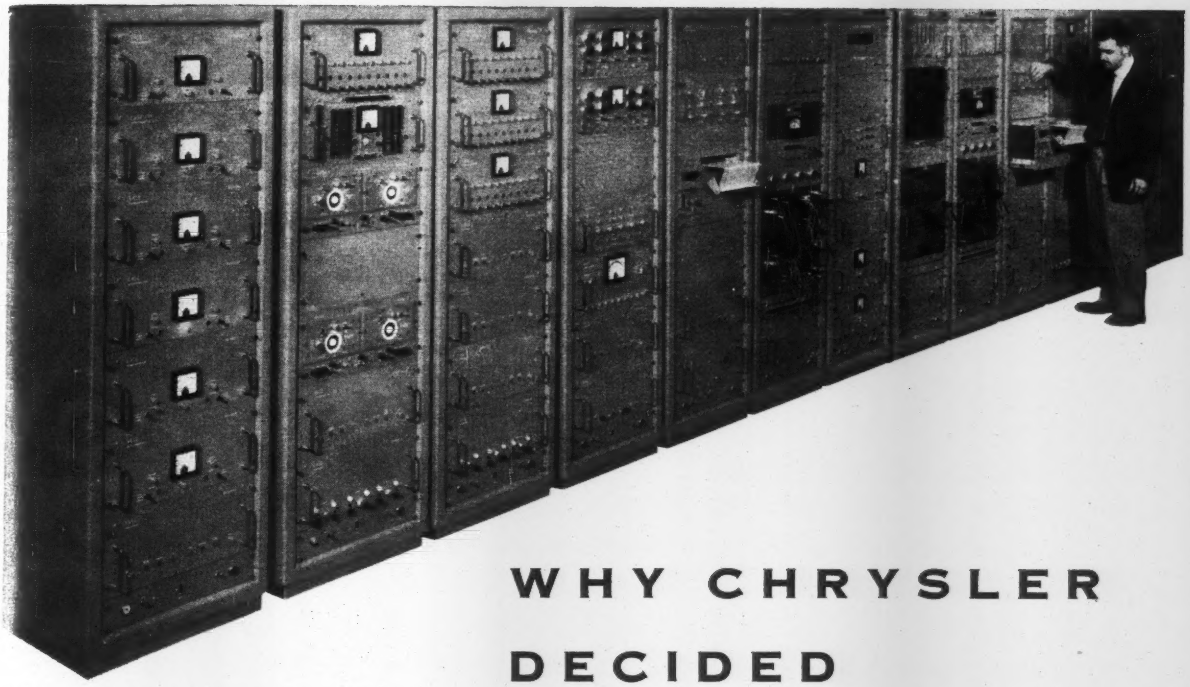
METAL SORTER

New "Metal Monitor" checks metals without laboratory analysis; can identify ferrous and non-ferrous

7114



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Chrysler Corporation's guided missile research engineers wanted more than the ordinary analog computer's savings in solution time. They wanted faster set-up; rapid, simple computer programming and operation; automatic data recording, and high accuracy.

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1. *Automatic pushbutton setting of diode function generators, which permits set-up of their 12 non-linear functions in a matter of minutes rather than hours, and provides high accuracy with drift-free representation of the required function.*

2. *Automatic "hold" of computation at any two pre-set times, by means of an elapsed time clock and pre-set hold circuitry.*

3. *Digital display and readout of any selected variable on printed tape at the rate of one per second, to an accuracy of 1 part in 10,000.*

4. *Timing matrix which provides signals at any time "t" between 1 and 999 seconds, for programming control.*

5. *Remote operation and automatic scale factor indication of the recorder, controlled by the computer.*

This is an excellent example of BERKELEY's ability to work closely with customers to develop computing and simulation equipment matched to specific requirements. Availability of BERKELEY's complete line of quality-computer components means early completion and substantial savings in costs. (Overall cost of the Chrysler EASE* computer was far lower than that of competitive equipment).

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metals by comparative testing with known samples; can be used to sort mixed metals of unknown character into homogenous groups.—*Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.*

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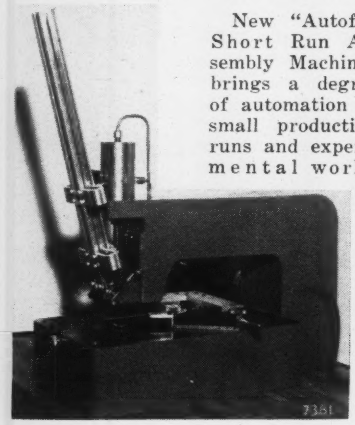
ASSEMBLY MACHINE

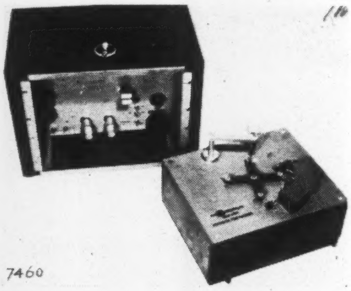


New "Autofab Short Run Assembly Machine" brings a degree of automation to small production runs and experimental work; was designed specifically to provide a flexible and reliable means of attaching electronic components to printed circuit boards where quantities involved are tens or hundreds instead of thousands. It is a semi-automatic machine; can be changed over from one component to a different one in less than a minute.—*Mechanical Div., General Mills, Inc., 1620 Central Ave., Minneapolis 13, Minn.*

For more information circle **405** on inquiry card.

AUTOMATIC CORE HANDLER

New "Model 4010," for high-speed handling of miniature magnetic memory cores in production testing, comprises mechanical handler, electrical control chassis (for sequencing operations), and remote control box; is said to be the only such equipment to take full advantage of magnetic properties of core to facilitate its handling. Cores are fed from a vibrating hopper under the influence of a magnetic field. Exciting current pulses are impressed through one set of contacts and core voltage response is read across a second set of contacts. Test rate up to one core per second. Grading bottle capacity 15,000 cores.—*Rese Engineering Co., 731 Arch St., Philadelphia 6, Pa.*

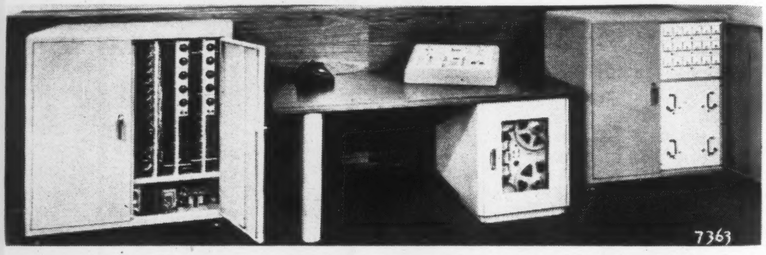


For more information circle **406** on inquiry card.

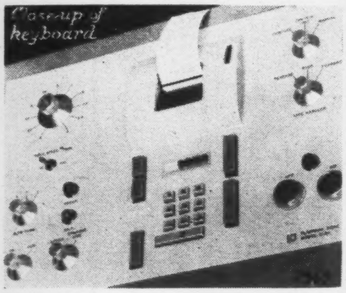
"PENCIL" SOLDERING IRON

New industrial soldering iron weighs one ounce and has a ⅛" tip; is said to be "designed and built to survive production-line punishment." It has maker's thermostatic action

MACHINE-TOOL CONTROLLER



New "Digimatic" is a numerical-type controller for automatic operation of machine tools. Main components: (1) "Planning Desk" comprising (a) keyboard into which dimensions of the finished part are entered, (b) computer which translates dimensional data into numerical instructions which are simultaneously recorded in pulse form on mag tape, and (c) power supply cabinet; (2) "Machine Control Unit" which converts mag tape pulses into operations of all feeds, drives, etc., of machine tool. System makes it possible to produce identical parts in shops in different cities by duplicate tapes, or, without transporting tape, by transmitting a tape's code over telephone or radio.—*Electronic Control Systems, Inc., 2136 Westwood Blvd, Los Angeles, Calif.*



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Omniguard improves plant efficiency and lets you operate at peak capacity because it unfailingly reports when dangerous temperature conditions occur at one or more points. And does it at surprisingly low cost.

A modular system of monitoring one to an unlimited number of points simultaneously, Omniguard watches continuously. When a bearing starts heating up or a process becomes critically hot, it automatically gives a warning and/or shuts down the equipment before it is damaged.

The low cost unit is easy to install. It is non-electronic and simplifies installation and maintenance through the use of copper wiring between all components.

See for yourself. A personal demonstration can be arranged at your own plant. Take it apart. Analyze it. Find out how simply Omniguard improves operating efficiency. Just write!

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THE BECKMAN LEAK DETECTOR finds leaks with production-line speed in vacuum, pressure and hermetically-sealed systems and units of any size. It is useful in the manufacture of instrument and electronic components, testing glass-to-metal seals and welded or soldered joints, maintenance of pressure and vacuum processing systems–wherever operating and shelf life and system efficiency are sharply reduced if even normally insignificant leaks are present.

A unique radio-frequency principle makes the Beckman Leak Detector a simpler, more reliable and less expensive mass spectrometer leak detector. It is sensitive to leakage rates down to 10^{-9} standard cc/sec., it is easy to use and completely safe for operator and system under test because inert helium is the leak tracing agent, and it is portable and dependable. Write for Data File N20-47 to Beckman Instruments, Inc., Process Instruments Dept., Fullerton, California.

Beckman *process instruments*

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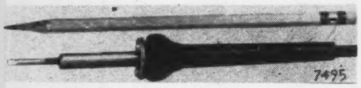
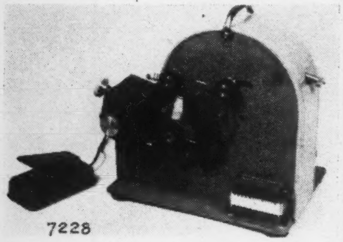


(without a fragile thermostat) to prevent fusing and tip-burning. Handle is cooled by "chimney" feature. Irons meet all government specs; are both UL and Canadian Standards approved.—*Wall Mfg. Co., Grove City, Pa.*

For more information circle **408** on inquiry card.

TOROID COIL WINDER

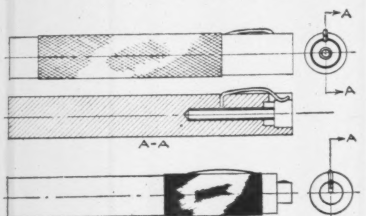
New "Midjet" eliminates tedious hand winding, insures uniform products, is exceptionally versatile; permits winding finished coils having an ID (hole) as small as 3/32″ by use of a unique method of winding off inside of shuttle (instead of top). Maximum finished coil diameter is 1″ and maximum height along toroid axis is ½″. Extremely fine wire sizes can be used without usual wire breakage and production slow-down. Wire sizes from 30 to 46 gage. Full 360° coverage of core. Wire can be accurately wound on core in any type of sector build-up required; also multiple windings with multiple leads separated.—*Electro Devices Co., Inc., 580 Main Street, Wilmington, Mass.*


7228

For more information circle **409** on inquiry card.

BEARING ASSEMBLY TOOLS

New inexpensive bearing assembly and bearing handling tools, equipped with a retaining spring finger to lightly grip bearing's inside bore or outside diameter, are available in male or female types. Pressure surfaces of tools prevent forces being applied through balls and races with consequent damage.—*The Baker Co., Inc., Maplewood, Maine.*



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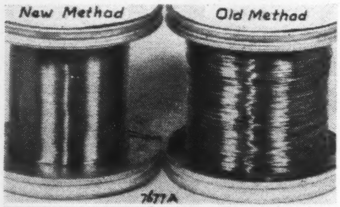
ELECTRIC BOX OVENS

New electrically-heated box ovens are of forced-air circulating type, with positive exhaust. Material treated can be placed on trays, or trays removed and larger pieces can be set individually or on racks. Temperatures to 500°F, automatically controlled. Inside spaces from 18x18x18″ to 48″ wide x 60″ deep x 60″ high; heating capacities from 6 kw to 30 kw. Large units set on floor.—*Drying Systems, Inc., 1800 Foster Ave., Chicago 40, Ill.*

For more information circle **411** on inquiry card.

SMOOTH-WOUND WIRE

New smooth-layer wound wire ends production headaches for manufacturers of subminiature electronic tubes whose high production costs and rejection rates are caused by ordinary commercially-wound wire "full of bends and kinks," with which it is impossible to maintain close tolerance. One manufacturer reduced rejection rate by 50% with smooth-layer wound wire and tube performance is better; another now guarantees industrial electronic tubes for 10,000 hours (previous guarantee 1000 hr).—*Techalloy Co., Inc., Rahns 1, Pa.*



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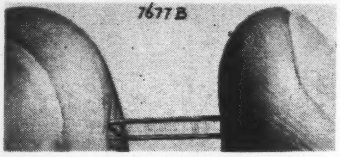
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For more information circle **412** on inquiry card.

PENETRATING OIL

New "Nu-Aero Penetrating Oil with Moly" is designed for speed in loosening frozen fittings, nuts, bolts, sheaves, etc. Its pressurized container makes it possible to carry penetrating oil in tool boxes without risk of spillage. Aerosol high-pressure stream facilitates application in difficult positions. Addition of molybdenum di-

New Underwood Servotyper records data automatically

Underwood proudly presents the new Servotyper for automatic recording of digitized and alphabetic data, plus all the advantages of the well-known rugged durability of the Underwood Electric Typewriter.

The Underwood Servotyper is a slave electric typewriter. The keys are operated by solenoids which are triggered by electrical signals, at speeds up to 11 characters per second. A great variety of standard devices—quantizers, digital converters, diode matrices, transducers with digital outputs, etc., are already available for translating data into electric signals. These signals are simply and directly used as inputs for automatic operation of the Underwood Servotyper.

The Underwood Servotyper can be applied to many data logging and telemetering problems—test and research results, process variables, maintenance data, meteorological data, etc.—anywhere information is secured by electrical instruments. For complete specifications and wiring diagram of the Underwood Servotyper, call your Underwood Office (the number is in the Yellow Pages of your phone book), or write Underwood Corporation, One Park Avenue, New York 16, New York.

Features of the new Underwood Servotyper

- Solenoid operation of all keys, space bar, shift key, back space, carriage return, tabulation and red ribbon.
- Solenoid operated by 100-volt direct current at 100-milliamperes d.c. with nominal resistance of 1,000 ohms. Also available with 24-and 48-volt d.c. Solenoids.
- Speed of operation to 11 characters per second.
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- Prices from $730.00

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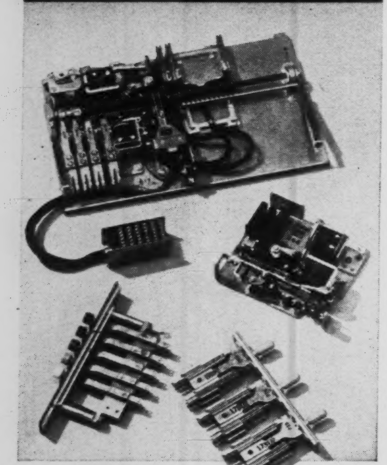

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sulfide produces a fluid which both loosens and lubricates even under extreme conditions.—*Pressure Products Co., West Chester, Pa.*

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UNICELLULAR RUBBER FLOATS

New floats of hard unicellular rubber sponge are fabricated to customer specification. New material, of minute sealed-cell structure, has a specific gravity of 0.14 (less than cork); will withstand higher temperatures than cork; is resistant to fungus growth; needs no protective coating, maintains stable weight and volume and is not subject to becoming "water-logged." In contrast to metal floats, it will not fail from vibration conditions or from puncture. It can be drilled or otherwise machined and can be molded to shape with or without metal mounting arm. —*Rubber Products Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.*

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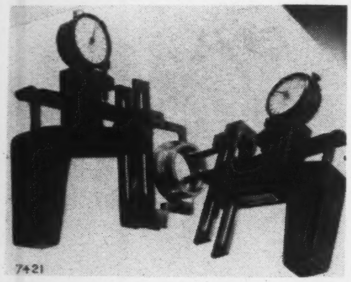
DIMENSIONAL GAGING and INSPECTION

ID & OD GAGE

New gage handles all inside and outside diameter measurement jobs; measures (for example) O rings and "Truarc" ring with the same set of tips. Neither gage nor dial indicator need be changed for any measuring job. Interchangeable tips provide a complete range from zero to 5.750″ for outside measurements and from 0.187″ to 6.270″ for inside measurements. (Tips for greater dimensions available.) Functionally designed pistol grip and light weight practically eliminate operator fatigue.—*Mueller Laboratory, Pasadena, Calif.*



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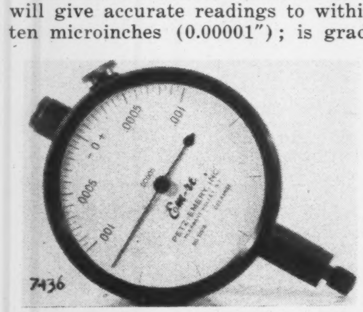
DIAL INDICATOR

New "Model 21019," dial indicator, will give accurate readings to within ten microinches (0.00001″); is graduated in 50 microinches over a measuring range of 0.002″. Bezel size is 2¼″. Precision action results from extremely simple construction and fully jeweled movements protected by "Em-re" 100% shock-proof system.—*Petz-Emery Inc., Pleasant Valley, N. Y.*



For more information circle **416** on inquiry card.

BENCH COMPARATOR

New bench model of maker's comparator enables both skilled and unskilled personnel to inspect parts quickly and accurately; checks pitch diameter on splines and gears (externally or internally); shoulder distances; center-to-center; OD and ID dimensions, etc.; is built for heavy-duty use. Capacity 6″.—*Jerpbak-Bayless Co., Solon Rd., Solon, Ohio.*

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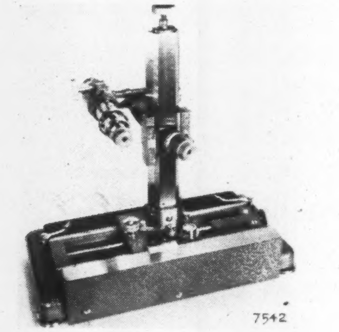
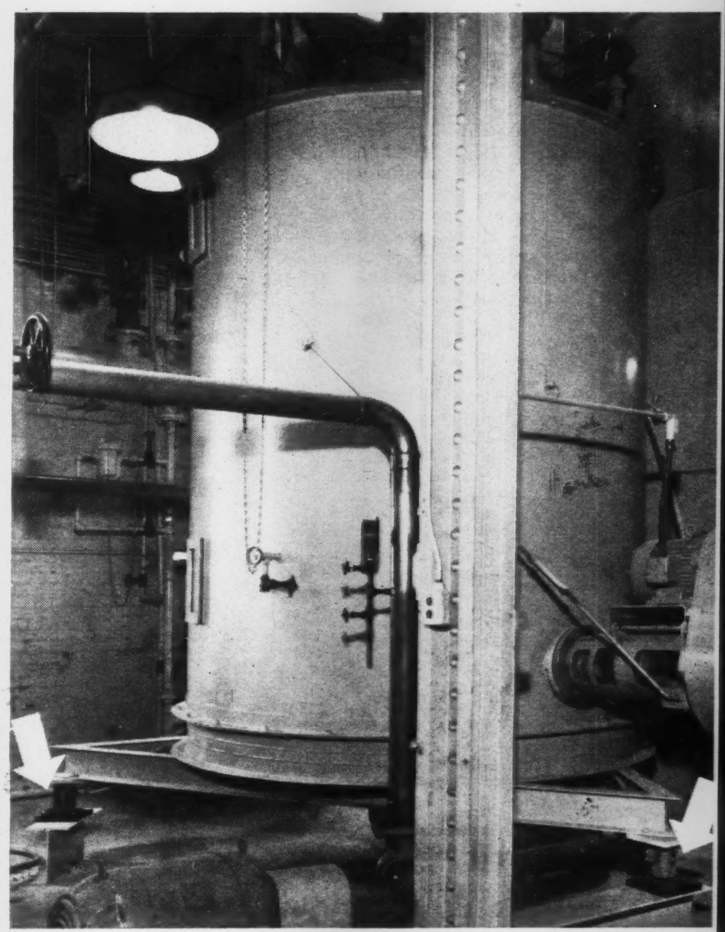
MEASURING MICROSCOPE

New measuring microscope reads direct by vernier to 0.01 mm on both its horizontal and vertical scales. In-



Baldwin SR-4® system controls mixing to .1% repeatability



In a west coast processing plant, liquid sugar is mixed automatically by a Baldwin SR-4 system whose accuracy is within .1% repeatability.

Here's how it works. A 2,500-gallon mixing tank and 10,000-gallon storage tank stand vertically on triangular frames whose corners rest on Baldwin SR-4 load cells (photo at right). These strain gage type cells measure tank weight changes and transmit electrical signals to a Baldwin indicator-controller (photo above) which shows total weight of tank contents in pounds.

To start the process, dry sugar and water valves are opened manually; from there on mixing is automatic. When the load cells signal that predetermined proportions have been reached, sugar and water flow are shut off by the indicator-controller.

Baldwin SR-4 systems can be developed for any application involving load, pressure, tension, torque or thrust. Custom-built systems range from simple weighing and measuring devices to complete feedback control. "Packaged" systems and component transducers are also available. For illustrated bulletins, write us at Dept. 2953, Electronics & Instrumentation Division, Waltham, Massachusetts.

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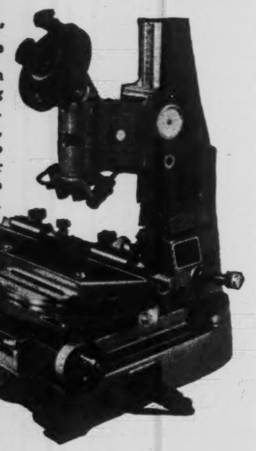
Toolmakers' Microscope

Ultimate in measuring microscopes. Range 2" x 4", reading to 0.0001", angular measurement to 1 minute.



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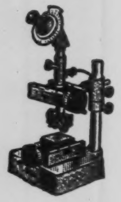
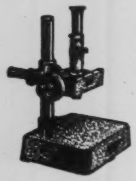


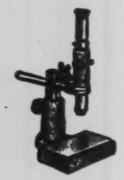
Coordinate Measuring Microscope

High precision, low cost instrument for 2-dimensional linear measurement. Range 2" x 2", reading to 0.0001".



Micrometer Slide Comparator

Reliable, low cost instrument for linear measurement. Ranges up to 4", reading to 0.0001" or 0.00005".



Scale Micrometer or Shop Microscope

High quality, low cost instrument with range up to 0.100". Reading to 0.001", easy interpolation to 0.0002".

Write for Bulletin 161-54 showing applications, models, specifications.

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For more information circle **97** on inquiry card.

terchangeable microscope and telescope objectives make it easily converted into a small cathetometer with a two-dimension field of 232 sq cm. Magnification 33, object field dia 2.0 mm, working distance 45 mm.—*The Ealing Corp., Box 90, Natick, Mass.*

For more information circle **418** on inquiry card.

CONTOUR PROJECTOR ACCESSORIES

Three new accessories increase usefulness of "Kodak Contour Projector Model 8." (1) Glass measuring stage for use in vertical projection is available with micrometers calibrated either to 0.001" or to 0.0001". Range 2"x1". (2) For measuring angles a rotary screen replaces standard ground glass screen. (3) For use in horizontal projection, overlay chart holder permits use of existing plastic or ground glass charts of varying sizes on the instrument. [Photo shows (1) and (2).]—*Optical Gaging Products, Inc., 26 Forbes St., Rochester 11, N. Y.*

For more information circle **419** on inquiry card.

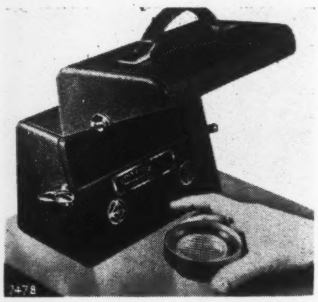
LEAD COMPARATOR

New "Model SK-1003" bench model lead comparator can measure the lead of threads in larger diameters and in longer lengths than could previous models; has a thread diameter range of 0.112" to 2". Length capacities, between points, from 0.25" to 6". Other sizes and capacities available on special order.—*Jerpbak-Bayless Company, Solon, Ohio.*

For more information circle **420** on inquiry card.

MONOCHROMATIC LAMP

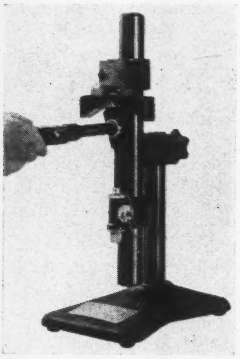
New "Mono-Light" for precise measurement of flatness features a helium lamp which "assures anyone can make precisely accurate measurements for flatness up to 1 light band (0.0000116") or less after minimum practice."—*Spitfire Tools Inc., 2931 N. Pulaski Road, Chicago 41, Ill.*



For more information circle **421** on inquiry card.

BORE-GAGE MASTER

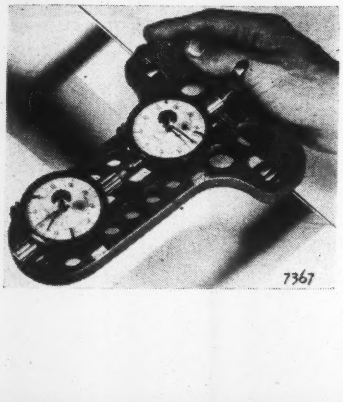
New "Adjustable Setting Master" for dial bore gages replaces a number of fixed master ring gages; is set by means of gage blocks to any desired dimension between 1" and 12⅛". A combination of requirements is met by swivelling column: Master is set with its adjustable anvil uppermost, and then column is rotated 180° to bring centralizing yoke on top.—*Standard Gage Co., Inc., Poughkeepsie, N. Y.*



For more information circle **422** on inquiry card.

SHEET GLASS GAGE

New "Model 259 P-140" permits measuring the thickness of a sheet of glass close to its edge. It has two dial



"Our lab is seeking work we used to turn away...

0 1 2 3 4 5 6 7 8 9 10

...we cut our analysis time to one-fifth with our NEW G-E XRD-5 X-Ray Emission Spectrometer"

THE above statement from a large steel foundry reflects the contribution of this versatile General Electric apparatus to analysis programs in chemical, rubber and petroleum plants, as well as in metallurgy.

G.E.'s new X-Ray Emission Spectrometer has proved far faster and more precise than wet methods for quantitative analysis of elements down to atomic number 12 (magnesium). And because the technic is non-destructive, re-runs can be made immediately without preparing another sample.

Whatever your analysis requirements — research, raw materials or quality control — this General Electric diffraction unit can be adapted to your exact needs. Our x-ray representative near you will be glad to recommend the facilities best suited to your work load. Or write to X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin, for Pub. BL-84.

HELIUM ATMOSPHERE and a flowing gas proportional counter help detect small atomic number elements.

XRD-5S SPECTROMETER may be used exclusively for chemical analysis or quickly rearranged as a diffractometer for crystal analysis.

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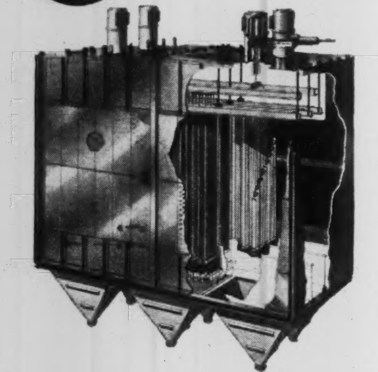
GENERAL ELECTRIC

For more information circle **98** on inquiry card.

case history:
KOPPERS COMPANY
RECOMMENDS
ANDEROL
SYNTHETICS



Thorough testing by the Engineering Department of the Koppers Company resulted in the manufacturer's recommendation of Anderol Synthetic Lubricants for the maintenance of huge Electrostatic Precipitators—widely used in industrial gas cleaning. Tests revealed that Anderol Synthetics reduced maintenance cycles and servicings for users of the precipitator to such a degree that savings of up to $2000 per year in lubrication costs were attained.

VERSATILITY, SERVICE

The versatility of Anderol products ranges from such large installations as the Koppers Precipitators to the smallest of precision bearings. Lehigh "custom tailors" the lubricant to the job, regardless of the quantity of lubricant or the scope of the project involved. *Your* lubrication problem will receive skilled laboratory attention, upon request.

Address inquiries to—
Lehigh Chemical Company,
Dept. 8, Chestertown, Maryland
Complete list of government products, samples and data also available upon request.

ANDEROL
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For more information circle **99** on inquiry card.

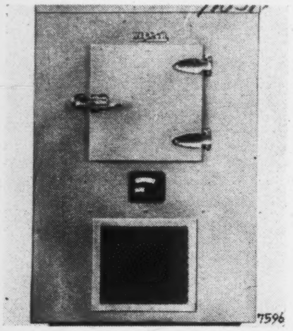
indicators, both equipped with special auxiliary magnetic hands, each free to be pushed by pointer to its extreme position and remain there. One hand gives maximum reading; the other minimum.—*Federal Products Corp; 1144 Eddy St., Providence 1, R. I.*

For more information circle **423** on inquiry card.

MECHANICAL TESTING

LOW-TEMPERATURE CABINET

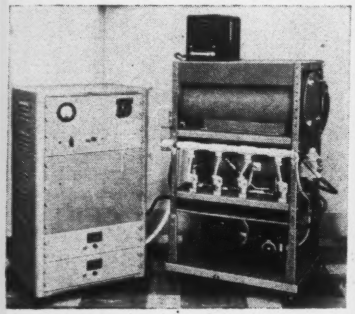
New 2-cu-ft "Model WE-2-140" has optional top lid or front door, triple-sealed with low temperature gasketing. Corners and seams of test chamber are especially designed and welded to allow for expansion and contraction. Heavy-duty industrial type temperature controllers; range 150°F to minus 150°F; control accuracy of 1F°.—*Webber Engineering Corp., P. O. Box 217, Indianapolis 6, Ind.*



For more information circle **424** on inquiry card.

DYNAMIC ALTITUDE SIMULATOR

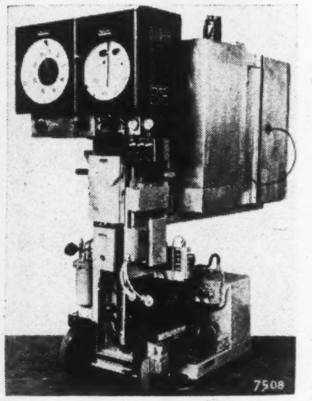
New Dynamic Altitude Simulator continuously reproduces equivalent flight conditions of modern high performance aircraft in altitude variations ranging from minus 1,000 ft to 80,000 ft. Developed and licensed by Westinghouse Electric Corp., instrument includes control arrangements which permit it to be commanded directly from an analog computer such as Reeves REAC. Equipment under test, placed in 9" by 24" long cylinder, can be subjected to pressure variations corresponding to 50,000 foot-per-minute altitude changes.—*Color Television Inc., 953 E. San Carlos, San Carlos, Calif.*



For more information circle **425** on inquiry card.

HOT AND COLD CABINETS

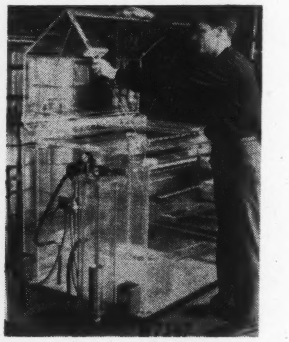
Two new models—stationary and mobile (latter shown) have temperature range −100°F to 600°F; choice of various types of automatic control and air circulation systems. Refrigeration system, using a new gas, can pull down to low temperatures rapidly—*Atmosphere Control Co., Inc., 5313 Chester Ave., Philadelphia 43, Pa.*



For more information circle **426** on inquiry card.

CORROSION TEST CABINET

New "Singleton H-T Sincolite" (transparent) test cabinet embodies refinements which have earned official approval as meeting ASTM and US Government specs. Cabinet holds to ± ½ F° which is said to be "closest tolerance yet achieved in this type of equipment."—*The G. S. Equipment Co., 5317 St. Clair Ave., Cleveland 3, Ohio.*



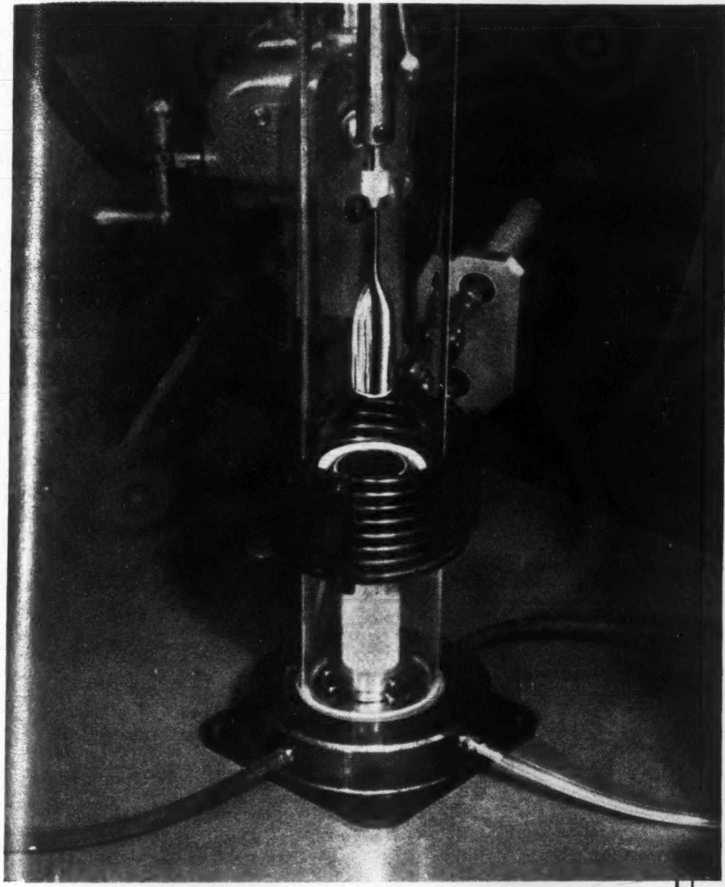
For more information circle **427** on inquiry card.

CREEP TESTER

New multiple creep rupture testing machine of lever type can hold four specimens simultaneously under loads

For closer temperature control in crystal growing...

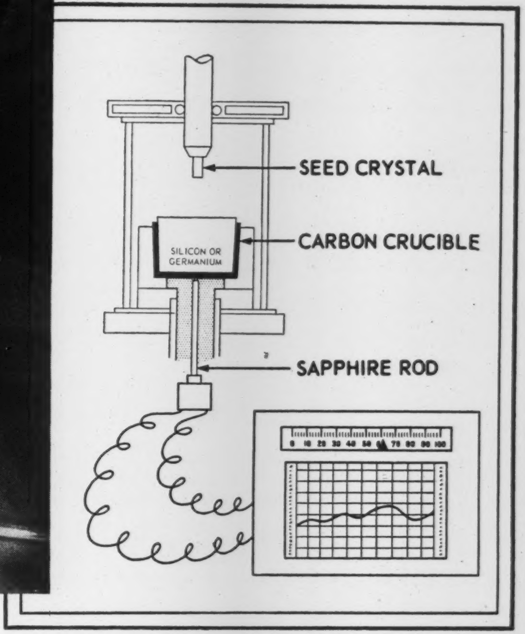
Photograph courtesy of Minneapolis Honeywell Regulator Company



A typical crystal-growing installation is shown here. The sapphire light pipe is focused on the base of the crucible, and projects below the table surface. (See detail at right.)

Linde
Trade-Mark

SAPPHIRE
Light Pipes



Volume production of germanium and silicon crystals used in transistors and diodes has spurred important developments in temperature measurement and control. In one new temperature measuring device a rod of **LINDE** synthetic sapphire is used as a light pipe. It has a refractive index of 1.77, furnishes reliable measurements at temperatures as high as 1850 degrees C., and allows temperature to be controlled to great accuracy.

LINDE synthetic sapphire—a single crystal of aluminum oxide—transmits a high percentage of radiation in important ultra-violet and infra-red regions. It has high mechanical strength, resists corrosion and abrasion, and retains its properties at high temperatures.

These and other attractive properties make sapphire ideal for other optical systems that require resistance to abrasion and corrosion as well as good transmission properties. It is also used for critical instrument parts that must resist extreme wear.

LINDE synthetic sapphire is available in the form of windows, rods, tubes, balls, and special shapes. If you would like more information on this product, please write, giving details of the proposed applications.

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LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation
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In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto

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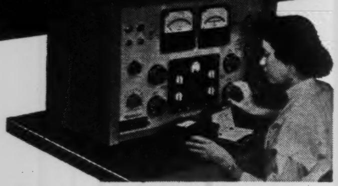
For more information circle **100** on inquiry card.



How to Calibrate Your own Instruments

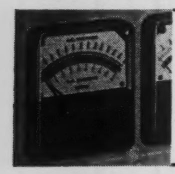
FAST ACCURATE CALIBRATION
Now possible with one completely self-contained AC-DC calibration standard requiring a minimum of operator training and previous instrument calibration experience.

Use the Compact Model 829
INSTRUMENT CALIBRATION STANDARD for

- ✓ LABORATORY STANDARDS
- ✓ PRODUCTION TESTING
- ✓ INSTRUMENT REPAIR
- ✓ INSPECTION & SERVICE

All Circuits, Power Supplies and Standards are contained in One Single Cabinet!

Precise, practically error-proof checking of most types of electrical indicating instruments in daily use is a routine convenience for Model 829 users. Maintenance of quality control by frequent calibration of instruments and allied test equipment can be accomplished within departments by available personnel. A mechanical index explains step-by-step test procedure.



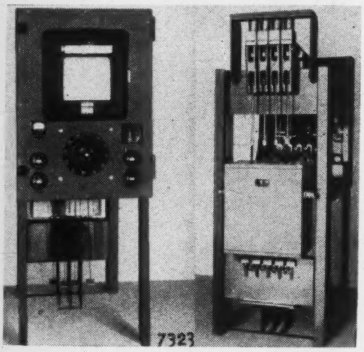
WESTON Special Meters
used as standards have 5-inch mirror precision scales, knife edge pointers and are adjusted to better than 0.2% accuracy.

Calibration to full scale accuracy of 0.5% can be accomplished for all instruments measuring d-c voltage (22 ranges) from 0.25 mv to 2000 volts, d-c current (22 ranges) from 2 µa to 20 amperes, a-c voltage (19 ranges) from 1.5 mv to 1500 volts, and a-c current (14 ranges) from 1.5 ma to 20 amperes. Net price $2345. FOB Boonton, N.J.

Write for Technical and Application Data.

Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **101** on inquiry card.

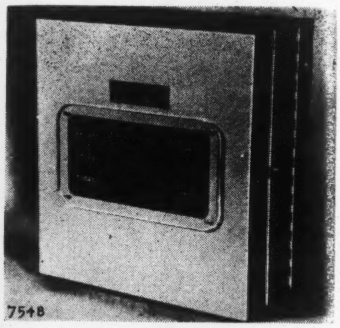


up to 4000 lb. A four-specimen electric furnace controlled by an "L&N" single-point indicating and recording controller holds specimens at any temperature up to 1800°F. A "Variac" voltage adjuster of 7 kva capacity is used for furnace control.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **428** on inquiry card.

STRAIN CYCLE COUNTER

New "Model 138E" can total strain cycles occuring within six different levels; incorporates a self-balancing strain gage bridge, servo amplifier and counters to register strain cycles as low as 500 psi; can collect loading and fatigue data under actual operating conditions.—*Dep't 55, Franklin Electronics Inc., East 4th St., Bridgeport, Pa.*



For more information circle **429** on inquiry card.

ELECTRICAL TESTING

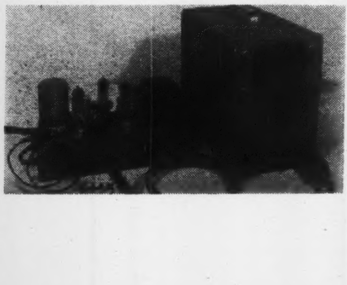
CAPACITANCE BRIDGE

New "Automatic Capacitance Bridge" simplifies procedure and reduces time required to obtain capacitance measurements of lab accuracy with unskilled operators. Instantaneous measurements are displayed directly on a servo-actuated dial with no need for balancing operations. Range 0 to 1000 mmf (can be extended). A kit of six precision capacitors is available for checking this or any precision capacitance bridge. These units are certified by National Bureau of Standards.—*Simmonds Aerocessories, 105 White Plains Rd., Tarrytown, N. Y.*

For more information circle **430** on inquiry card.

AMPLIFIER TESTER

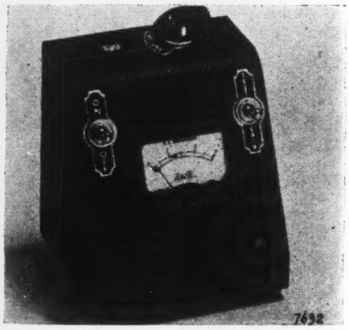
New "141-A Analyzer" for Brown "ElectroniK" continuous-balance amplifier units makes it possible to trouble-shoot these amplifiers while installed; eliminates unnecessary amplifier replacing; minimizes shutdown time; is connected through tube socket plug adapters (as illustrated) without disturbing either input or output amplifier connections.—*Parameters, Inc., 195 Herricks Rd., New Hyde Park P. O., N. Y.*



For more information circle **431** on inquiry card.

TRANSISTOR TESTER

New "Fretco Transistor Tester" quickly determines optimal application of transistors; checks all junction transistors for shorts, opens, leakage, and current gain; is wired for checking both *p-n-p* and *n-p-n* types.—*Fretco, Inc., 406 N. Craig St., Pittsburgh 13, Pa.*

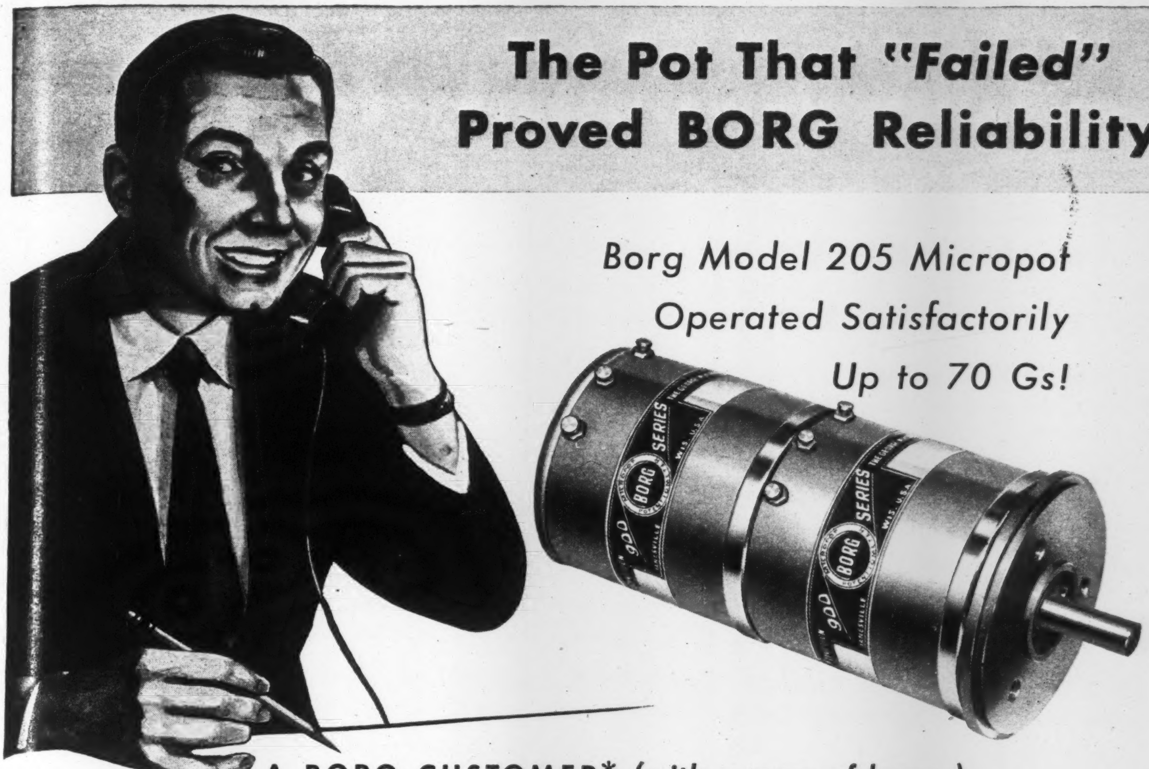


For more information circle **432** on inquiry card.

CIRCUIT ANALYZER

New "Model 144NX Universal Automatic Electrical Circuit Analyzer," designed expressly and exclusively for military use, is an adaptation of mak-

The Pot That "*Failed*" Proved BORG Reliability



Borg Model 205 Micropot Operated Satisfactorily Up to 70 Gs!

A BORG CUSTOMER* *(with a sense of humor)* WAS ON THE PHONE . . .

"Your model 205 Micropot failed on test."

"What test?" we asked.

"We vibrated it over an extremely wide range 0 to 500 CPS and that 205 Borg Micropot operated satisfactorily up to 70 Gs. Then it failed."

"Did you say 70 . . . seven zero Gs?"

"I certainly did. Please forgive my kidding you a little and tell me something. How can you build an item of such precision that will withstand the terrific punishment of vibration shocks 70 times the acceleration of gravity? What holds the resistance in place? Do you glue it in?"

We answered, "Better than that. We encapsulate it in the housing. The resistance winding is positioned on a very accurately ground steel mold core. End leads and terminals are soldered on and the whole assembly is molded into a unit contained in the bakelite housing. This is an exclusive advantage of Borg Micropots. Only Borg does it this way."

"Now I understand how you get that permanent reliability. But how do you guide the contact to retain such accuracy right up to the point where the structure fails?"

"Here again is an exclusive Borg advantage", we told him. "The contact is guided over the resistance helix by a precision-ground lead screw so that only the contact touches the sensitive element. This lead screw is integral with the mounting surface so concentricity is built-in for life.

"Incidentally, the new 900 Series Micropots have a hollow lead screw to allow two or more units on a single shaft. This eliminates mis-phasing and sloppy drives."

"O.K., I get that", said our customer, "but will you guarantee your Micropots for 60 Gs vibration?"

This was the curve he'd been waiting to throw us. We said, "While most of our 900 Series Micropots will probably meet such a requirement, we won't guarantee it. However, we *will* guarantee them to meet all the requirements of MIL-R-12934. Your own evidence that Borg Micropots withstood 70 Gs vibration is just further proof of the large safety factor built into all Borg Micropots for reliability and long life."

*Name supplied on request.

Write for Complete Engineering Data

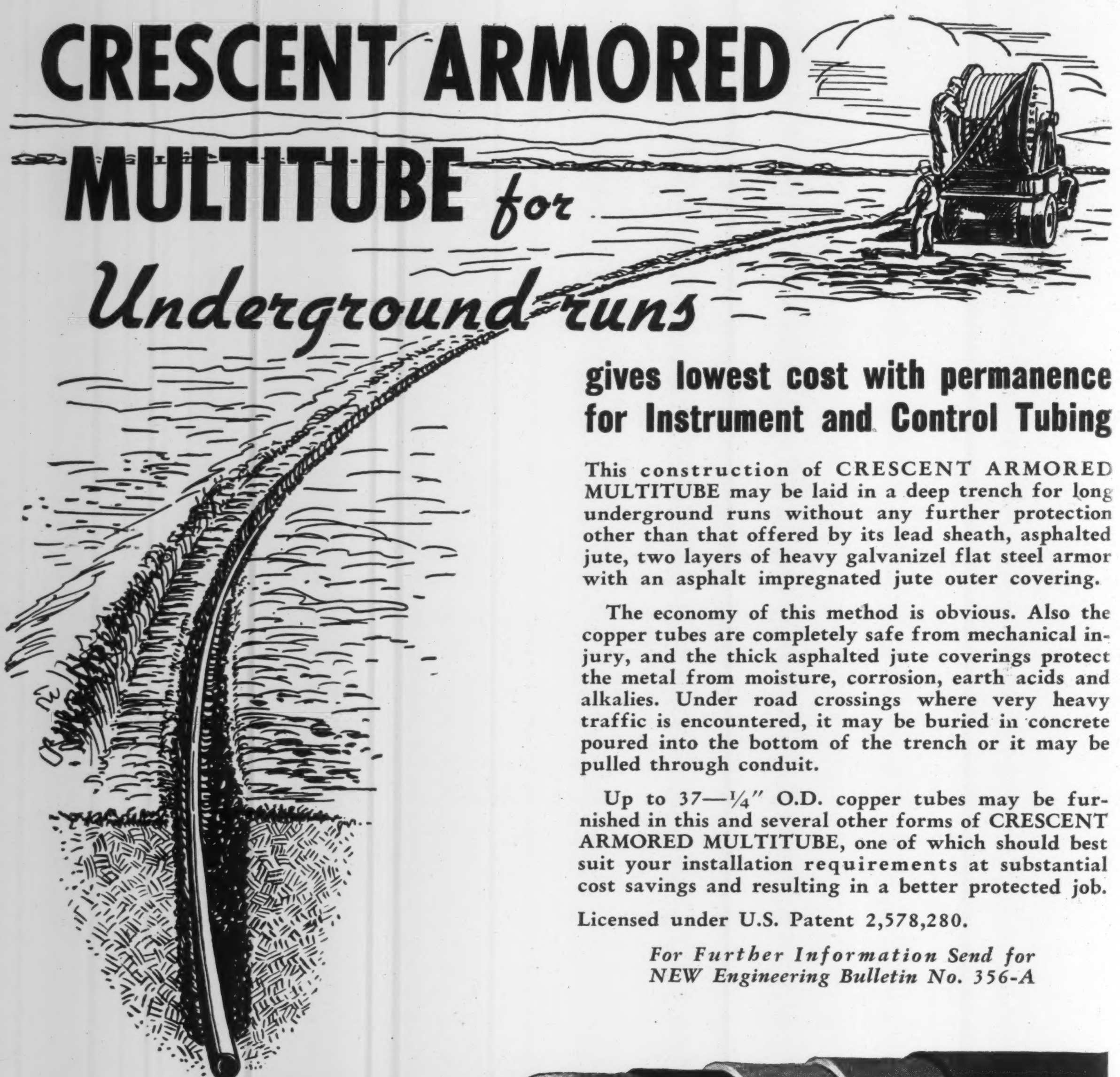
BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC — MECHANICAL
BORG
EQUIPMENT

Built by Borg

For more information circle **102** on inquiry card.

CRESCENT ARMORED MULTITUBE *for Underground runs*



gives lowest cost with permanence for Instrument and Control Tubing

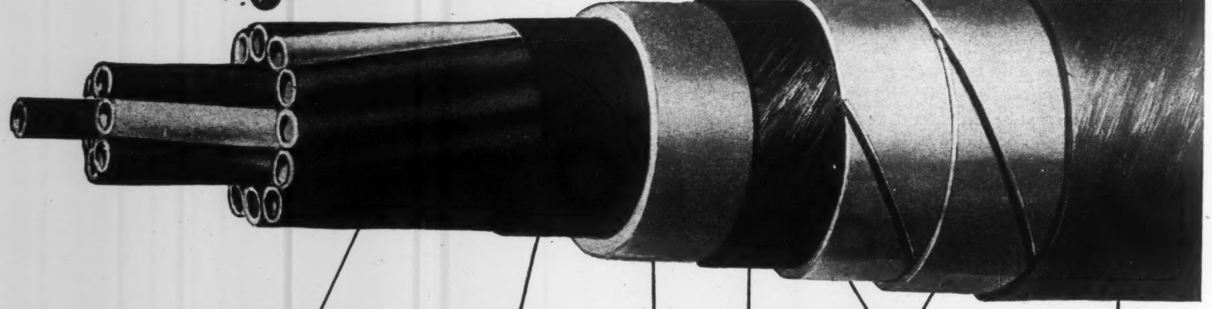
This construction of CRESCENT ARMORED MULTITUBE may be laid in a deep trench for long underground runs without any further protection other than that offered by its lead sheath, asphalted jute, two layers of heavy galvanizel flat steel armor with an asphalt impregnated jute outer covering.

The economy of this method is obvious. Also the copper tubes are completely safe from mechanical injury, and the thick asphalted jute coverings protect the metal from moisture, corrosion, earth acids and alkalies. Under road crossings where very heavy traffic is encountered, it may be buried in concrete poured into the bottom of the trench or it may be pulled through conduit.

Up to 37—¼" O.D. copper tubes may be furnished in this and several other forms of CRESCENT ARMORED MULTITUBE, one of which should best suit your installation requirements at substantial cost savings and resulting in a better protected job.

Licensed under U.S. Patent 2,578,280.

For Further Information Send for NEW Engineering Bulletin No. 356-A

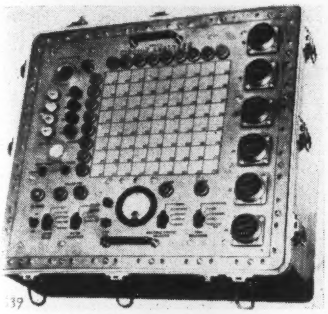


CRESCENT INSULATED WIRE AND CABLE CO.

TRENTON, NEW JERSEY

Visit Our Exhibit in Booth No. 611 at the Instrument Show, Sept. 17-21

For more information circle **103** on inquiry card.



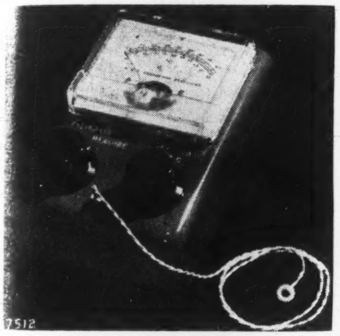
39

er's "Model 200 Circuit Analyzer." It is completely waterproof, shockproof and vibration-resistant; features simplicity of operation in field and on flight line.—*Dit-Mco, Inc.*, 911 *Broadway, Kansas City* 5, *Mo.*

For more infomation circle **433** on inquiry card.

TRANSISTOR THERMOMETER

New "Model 1 Power Transistor Thermometer" is of high impedance and with 35-to-85°C scale range for



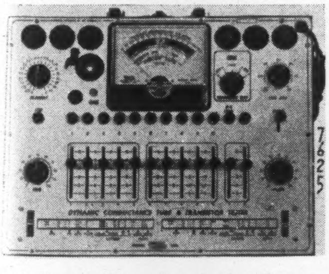
7512

applicability to germanium power transistor measurements. Primary element is normally mounted with same screw or stud as power transistor under test. Several sizes of primary elements are available, for No. 4, No. 10 and ¼" screws.—*B & B Engineering Associates, Beech Hill, RFD No.* 1, *Concord, N. H.*

For more information circle **434** on inquiry card.

TUBE & TRANSISTOR TESTER

New "Dynamic Conductance Tube & Transistor Tester #666" is said to feature speedy, simple operation,



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close simulation of actual tube operating conditions, sensitivity, accuracy and ruggedness.—*Electronic Instrument Co., Inc.*, 84 *Withers St., Brooklyn* 11, *New York.*

For more information circle **435** on inquiry card.

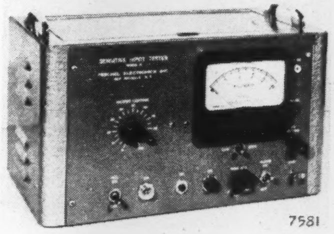
RADIO & TV TESTER

New "Capacohmeter Model 383-A" enables serviceman to locate seven out of 10 "leakers" by applying test leads to each end of capacitor. Disconnection and reconnection being virtually eliminated, serviceman can cut capacitor service time by 75%. Coupling capacitors are checked by means of an auxiliary three-lead test. Feature is unique "pulse" test surge of current or "pulse" whereby serviceman knows immediately that a capacitor is bad.—*Simpson Electric Co.*, 5200 *W. Kinzie St., Chicago* 44, *Ill.*

For more information circle **436** on inquiry card.

HV INSULATION TESTERS

New "Series H HiPot" testers automatically deenergize high voltage when leakage current in samples



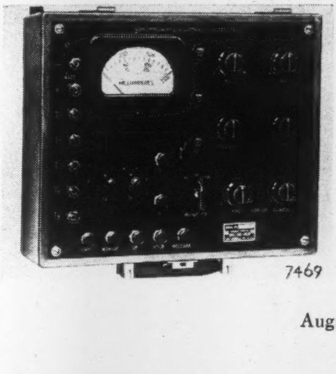
7581

reaches 5 microamps. Models are available from 2 kv up to 120 kv and special units can be custom built. Smaller units are adjustable up to 1000 microamps and larger units up to 5000 microamps. Maker states that new tester "avoids the brute force method of burning up fine equipment and components when testing for leakage. . . . allows convenient and accurate dielectric testing . . . shows up leakage currents in insulation which appear to be perfect on less sensitive instruments."—*Peschel Electronics Inc.*, 17 *Garden St., New Rochelle, N. Y.*

For more information circle **437** on inquiry card.

CURRENT FLOW TESTERS

New testers speed and simplify checking and adjustment of relays, solenoids, stepping switches, and similar electromechanical devices; are used to apply correct current to relays to check such values as OPERATE (minimum pull-in current), NON-OPERATE (maximum current which will not operate relay), RELEASE (current



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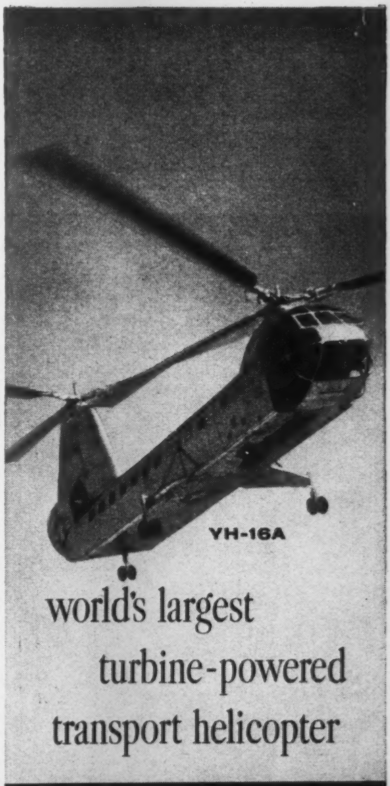

...designed
and built by
Piasecki

...uses
Statham
Accelerometers
to gather
invaluable
test data

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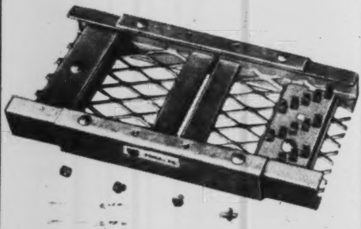
12401 W. Olympic Blvd., Los Angeles 64, Calif.

For more information circle **104** on inquiry card.

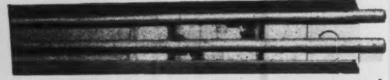
SPECIFY

P.W

for Supporting Instrument Tubing



P-W Manufactures a complete trough system with channel connectors. Drive rivets are used for quick assembly.—Extension Connectors eliminate field cutting—Adjustable connectors for any change in direction or elevation—I Section for long spans—Tube Clips—Cushion Clamps



Raceway to support a limited number of tubes with connectors, elbows, tees, etc.—Bulkhead Bar. P-W systems are available in widths from 1" to 24" and in lengths from 1' to 16'.

Twist-Rack

The Structure To Support Tubetrof . . . Cabletrof . . . Shelving . . . Conduit . . . Cables . . . Pipe, Etc.

Write today for Bulletin 955-D

P-W INDUSTRIES, INC.
Duncan & Melrose Sts.,
Philadelphia 24, Pa.

(Representatives to serve you!)
See Us at the ISA Show Booth 718

For more information circle 105 on inquiry card.

at which relay drops out), HOLD (minimum current which keeps relay closed) and SATURATE (a pre-testing polarization procedure). All circuits are identified and controlled from front panel, and each can be quickly adjusted without disturbing other circuit settings. Mechanical adjustments can be made without disconnecting and electrical tests can be repeated without resetting circuits. —*Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.*

For more information circle **438** on inquiry card.

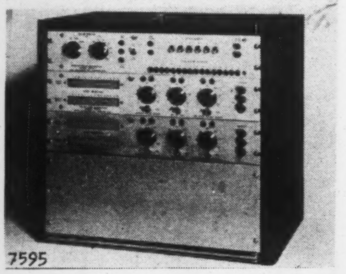
V-F OSCILLATOR

New "Model PMO-3" direct-reading high-precision variable-frequency oscillator can be used as a VFO, exciter and heterodyne frequency meter; features maximal reliability through minimal use of electronic tubes. Mechanical counter-&-dial system is coupled to a correction cam to provide linear calibration. First four figures (kc) appear as digits and last three figures (cps) are read on dial.—*The Technical Material Corp., 700 Fenimore Rd., Mamaroneck, N. Y.*

For more information circle **439** on inquiry card.

PULSE GENERATOR

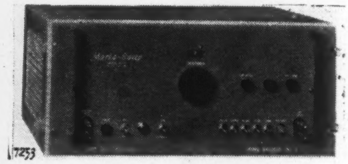
New programmed pulse generator permits setting up, in seconds, an arbitrary pulse pattern of negative and positive going pulses of variable width and of variable delay time. Master generator is adjustable in period from 8 usec to 0.1 sec with up to 64-bit word length and two or more pulse code generators, each with positive or negative going output of up to 16 direct and 16 delayed pulses adjustable in width and delay from 1 to 12,000 usec.—*Wang Labs., Inc., 37 Hurley St., Cambridge 41, Mass.*



For more information circle **440** on inquiry card.

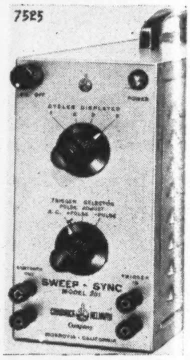
SWEEPING OSCILLATOR

New "RF-P Marka-Sweep" all-electronic sweeping oscillator with marks has 1-V output automatically held constant over both frequency sweep and frequency range.—*Kay Electric Co. Pine Brook, N. J.*



For more information circle **441** on inquiry card.

'SCOPE SWEEP GENERATOR

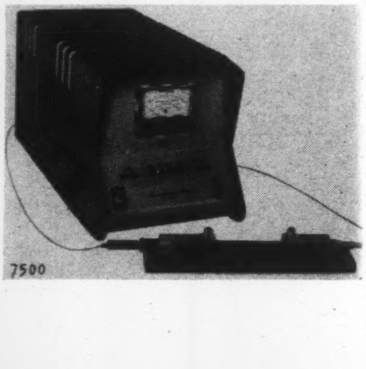


New "Sweep-Sync" automatic sweep generator for C-R 'scopes saves set-up and operating time and allows more thorough analysis and testing. In production, 'scope can be used with less-skilled help. It produces linear horizontal sweep for displaying a selected number of cyles of vertical axis signal automatically, continuously, and independently of frequency. Once number of cycles is set, it remains constant. Operator can focus all his attention on productive work, and thus obtain more information in a given time.—*Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif.*

For more information circle **442** on inquiry card.

NOISE GENERATORS AND AUTOMATIC NF INDICATOR

Two new noise generators both utilize an argon-filled gas tube standard (accurate to better than 0.25 db) making available 15.28 db relative excess noise temperature: "Type 70A" (illustrated) is for use as a white source over broad range of 200 to 2300 Mc; "Type 70B" (not shown) has its frequency limits set by the waveguide through which it is inserted. ★ New "Type 72" automatic noise figure indicator is the first commercially-available instrument of its

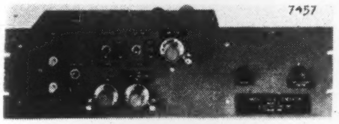


kind to make NF measurement fully automatic—the only one able to indicate directly, during measurement, the effects of making adjustments on the receiver under test.—*Airborne Instruments Laboratory, Mineola, N. Y.*

For more information circle **443** on inquiry card.

PULSE GENERATOR FOR MAGNETIC CORE SYSTEMS

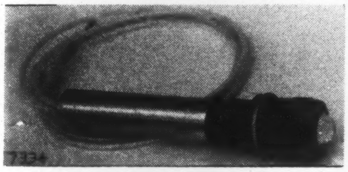
New "Model 6" delivers positive-going rectangular-wave current pulses of variable duration, rise time and amplitude; is a four-stage unit comprising multivibrator, inverter-amplifier, cathode follower and current amplifier. Multivibrator permits selection of any pulse width from 1 to 40 usec. Inverter-amplifier provides a rise-time range from 0.15 to 1.0 usec. Output amplitude can be varied from 0 to 2 amp.—*The Reflectone Corp., Myano Lane, Stamford, Conn.*



For more information circle **444** on inquiry card.

PHASE SEQUENCE INDICATORS

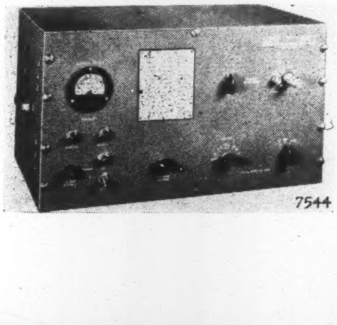
New "Model AC" units combine function of a pilot light and phase sequence indicator for portable three-phase equipment and instruments. An electrical network senses phase rotation and provides a voltage greater than or less than that required to light a neon indicator. Lighting of the neon indicates that phase sequence is A, B, C. Indicator head can be of standard commercial or military versions. A single panel hole is required for mounting. Units are available for 60- or 400-cps operation for systems having line-to-line nominal voltages of 110, 220, or 440.—*Brunswick Instruments, P. O. Box 813, New Brunswick, N. J.*



For more information circle **445** on inquiry card.

UHF IMPULSE GENERATOR

New "Model IG-118 Microwave Impulse Generator" produces pulses of fractional millimicrosecond duration,



THE *New* VICTOREEN CONDENSER r-METER

SIMPLIFIES AND IMPROVES *PRECISE* RADIATION MEASUREMENT

The newly designed Model 570 Condenser r-meter now takes its place beside the accepted standard of measurement of X and gamma rays—the Victoreen Model 70. Noteworthy mechanical simplification and improvements result in specific operating advantages. Among them are convenient 110 volt operation, elimination of trial charging approximations, and absence of temperature correction.

Thimble chambers for many conditions of energy, intensity and total dose are interchangeably used on both models. Intensity ratings are tripled on the Model 570. Complete information may be obtained from catalog 3043. Ask for it.

FEATURES

Convenient 110 volt operation (220 V on request)

Rapid, sure zeroing — no trial approximations

Illuminated, dual linear scales

New, rugged electrometer string suspension

Interchangeable ion chambers

Built-in light indicates operation and de-humidifies too

Lightweight, compact, and portable

INSTRUMENTS DIVISION

The Victoreen Instrument Co.

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For more information circle **106** on inquiry card.

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For more information circle 107 on inquiry card.

obtained by discharging a coaxial line into a load impedance through a pair of discharge contacts. Pulse duration is determined by length of charged line. Output pulses produce an exceptionally broad RF spectrum, 100 to 1,000 Mc, flat within ½ db. (A special version producing usable power up to 40,000 Mc can be obtained). Maximum peak power output 9000 uv per megacycle of bandwidth.—*Empire Devices Products Corp.*, 38-15 *Bell Blvd.*, *Bayside, L. I.*

For more information circle **446** on inquiry card.

ELECTRICAL and ELECTRONIC INSTRUMENTS

DIGITAL VOLTMETER

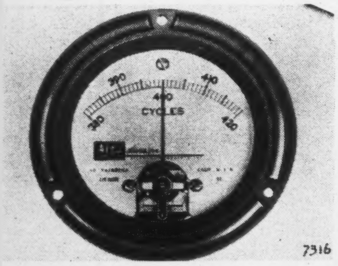
New "Model 1040 Digital Voltmeter" with automatic calibration, 0.01% stability, and other unique features has a range of 0.001 to 999.9 volts. Input impedance is 1,000 megohms on 9.999 scale and 11 megs on other scales. Calibration is continuous and automatic, as is polarity and range switching.—*Electro Instruments, Inc.*, 3794 *Rosecrans St.*, *San Diego* 10, *Calif.*

7358

For more information circle **447** on inquiry card.

FREQUENCY METERS

New expanded-scale 400-cps frequency meters for panel mounting (3½") have a span of 380-420 cps with 0.5% accuracy at mid-scale and 1% accuracy at extremes; temperature range −55°C to 65°C; input voltage 100 to 130. Military models are ruggedized and sealed.—*Argo Div., Beckman Instruments*, 220 *Pasadena Ave., South Pasadena, Calif.*

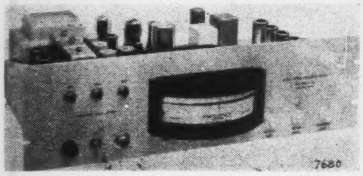


7316

For more information circle **448** on inquiry card.

400-CPS FREQUENCY METER

New "Model 6505A" 400-cps frequency meter is designed for laboratory and control applications. Overall accuracy is 0.1% or better at all frequencies in its frequency range of 370 to 430 cps. Scale can be expanded to increase mid-scale reading accuracy. Instrument is calibrated at 370, 400, and 430 cps by three built-in precision tuning fork oscillators. Recorder output circuit (linearity better than 0.1%) can be adjusted to 1-volt output for 30-cps frequency deviation —*Varo Mfg. Co., Inc.*, 2201 *Walnut St., Garland, Texas.*

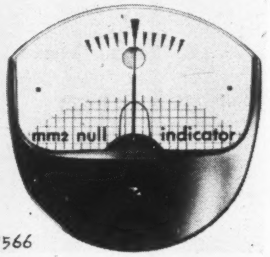


7680

For more information circle **449** on inquiry card.

NULL INDICATOR

New "MM-2" model of "Medalist" 2½" null indicator offers greater readability than conventional round instruments of same size; features high null-point sensitivity with sharp square-law attenuation, allowing accurate observation of large amounts of unbalance in circuit without physical or electrical overload of instrument. Available in three sensitivities (½, 1 and 2 ua/mm at null point), with full-scale current ratings of 100, 200 and 500 ua, respectively.—*Marion Electrical Instrument Co.*, *Grenier Field, Manchester, N. H.*



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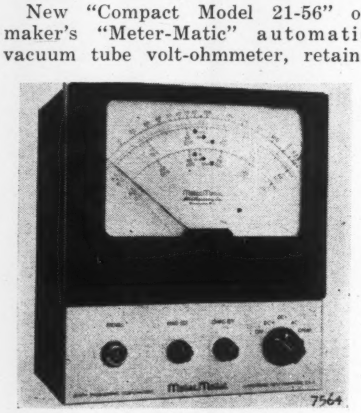
For more information circle **450** on inquiry card.

VTVOM

New "Compact Model 21-56" of maker's "Meter-Matic" automatic vacuum tube volt-ohmmeter, retains



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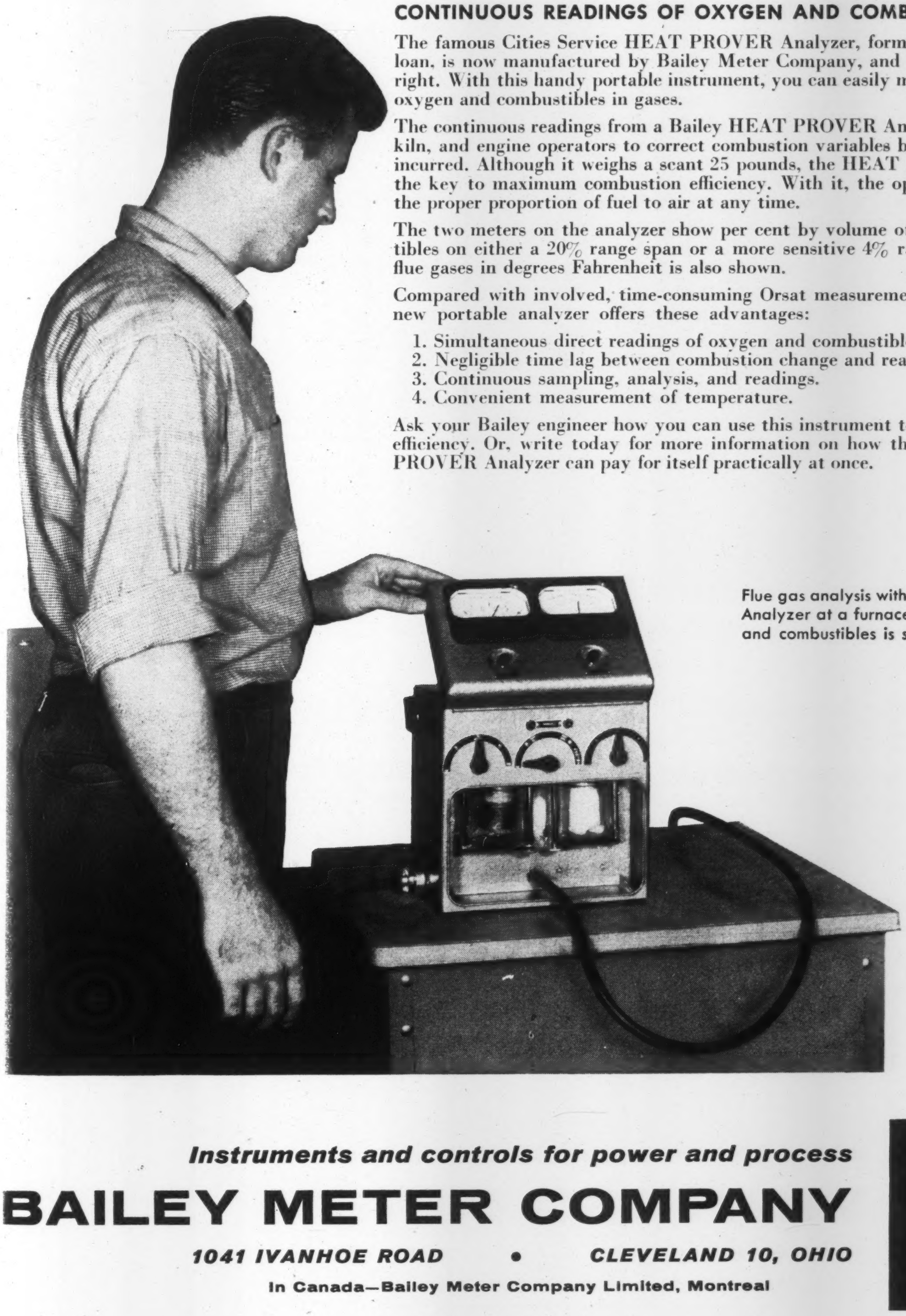
Now you can buy a
Bailey-built HEAT PROVER Analyzer



CONTINUOUS READINGS OF OXYGEN AND COMBUSTIBLES

The famous Cities Service HEAT PROVER Analyzer, formerly available only on loan, is now manufactured by Bailey Meter Company, and you can buy one outright. With this handy portable instrument, you can easily monitor the per cent of oxygen and combustibles in gases.

The continuous readings from a Bailey HEAT PROVER Analyzer enable furnace, kiln, and engine operators to correct combustion variables before costly losses are incurred. Although it weighs a scant 25 pounds, the HEAT PROVER Analyzer is the key to maximum combustion efficiency. With it, the operator can determine the proper proportion of fuel to air at any time.

The two meters on the analyzer show per cent by volume of oxygen and combustibles on either a 20% range span or a more sensitive 4% range. Temperature of flue gases in degrees Fahrenheit is also shown.

Compared with involved, time-consuming Orsat measurements of flue gases, this new portable analyzer offers these advantages:

1. Simultaneous direct readings of oxygen and combustibles.
2. Negligible time lag between combustion change and reading change.
3. Continuous sampling, analysis, and readings.
4. Convenient measurement of temperature.

Ask your Bailey engineer how you can use this instrument to increase combustion efficiency. Or, write today for more information on how this new Bailey HEAT PROVER Analyzer can pay for itself practically at once.

G-39-1

Flue gas analysis with a Bailey HEAT PROVER Analyzer at a furnace stack. Per cent oxygen and combustibles is shown continuously.

Instruments and controls for power and process

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BAILEY METERS

For more information circle **108** on inquiry card.

Where's the Trouble?

SCAM SEQUENTIAL ANNUNCIATORS Will Tell You!

Scam sequential annunciator systems provide an audible and flashing visual signal on the first alarm to enable the operator of your control board to determine which point in the monitored process first becomes abnormal . . . successive alarms that develop from the original abnormal condition are indicated by a steady visual signal. You can take proper corrective measures immediately because you *know* where the trouble started.

Shown here is a typical standardized Scam DE-LINE cabinet with integral flasher and reset pushbutton, featuring all the Scam advantages including simple, compact plug-in design.

If you've a process or system that needs automatic, fail-safe, low cost monitoring write us for literature or call the nearest representative in the cities listed below.

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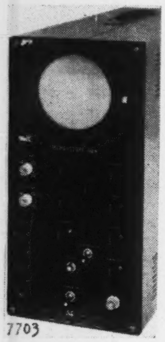
For more information circle **109** on inquiry card.

all the performance features of "Model 20-55," including fully automatic range-switching, automatic scale indicator lights, direct reading and burn-out protection up to 2000 v. It is smaller (10x8½x6") and weighs less (11 lbs).—*Leitch Engineering Corp., 326 Lincoln St., Manchester, N. H.*

For more information circle **451** on inquiry card.

INFINITE-PERSISTENCE OSCILLOSCOPE



7703

New "Memo-scope 102" self-contained storage 'scope presents all stored waveforms at equal constant brightness until intentionally erased, permits display of single transients or comparing a number of waveforms simultaneously without photographing. It is primarily designed to operate with any standard electrostatic-deflection 'scope; can also be operated using front-panel connections to amplifiers. Among other features: hinged camera mount; astigmatism correction for spot focus; contrast enhancement oscillator.—*Advanced Electronics Mfg. Corp., 2025 Pontius Ave., Los Angeles 25, Calif.*

For more information circle **452** on inquiry card.

PRECISION PHASE INDICATOR

New "Model 400 P Phaseometer" has direct-reading digital readout to 0.1°; requires no chart conversion, no special equipment for calibration, no tubes, batteries or external power. Frequency range is 350 cps to 15 kc usable to as low as 40 cps. Accuracy at 400 cps is 0.25° or better when unit is used as instructed.—*Winco Electronics, 644 N. Hawthorne Blvd., Hawthorne, Calif.*

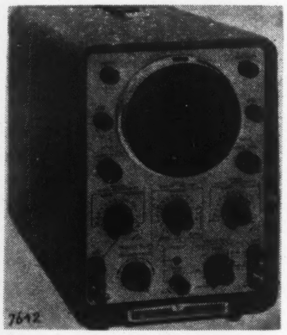
PHASEOMETER
MODEL 400-P
SIGNAL INPUT
CALIBRATE
OPERATE
EXT. CIRCUIT
OSCILLOSCOPE

7794

For more information circle **453** on inquiry card.

L-F OSCILLOSCOPE

New "Model 130A" low-frequency oscilloscope has nearly identical horizontal and vertical amplifiers which provide a maximum sensitivity of 1 mv/cm or 10 mv full-scale deflection with pass bands from dc to 300 kc and can accept balanced inputs on its five most sensitive ranges. Amplifiers also accept single-ended inputs, either ac or dc coupled. Sweep circuit employs a linear Miller-integrator triggered sweep instead of relaxation oscillator or bootstrap types normally found in its price range; producing an accurate calibrated sweep, from 1 usec/cm to 15 sec/cm.—*Hewlett-Packard Co., Dept. P, 395 Page Mill Rd., Palo Alto, Calif.*



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For more information circle **454** on inquiry card.

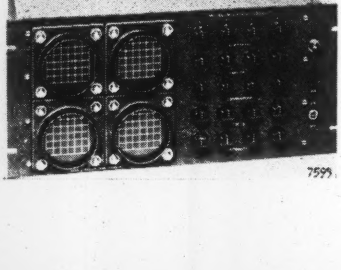
RECTILINEAR-RECORDING OSCILLOGRAPHS

New models of maker's multi-channel oscillographs in two, four, six and eight channels feature rectangular coordinate recording with hot stylus or ink writing; are designed for interchangeability from rectilinear to curvilinear recording.—*Photron Instrument Co., 6516 Detroit Ave., Cleveland 2, Ohio.*

For more information circle **455** on inquiry card.

MULTIPLE OSCILLOSCOPES

New "Multiscopes" are unique combinations of standard electronic indicating units comprising oscilloscopes of 1, 2 or 4 tubes but without sweep wave forms. Each assembly, mounted in a standard 19" rack panel, is fully supported from face of panel and no supplementary bracing is necessary. No connections are necessary on panel face. A unique shielded turret at rear



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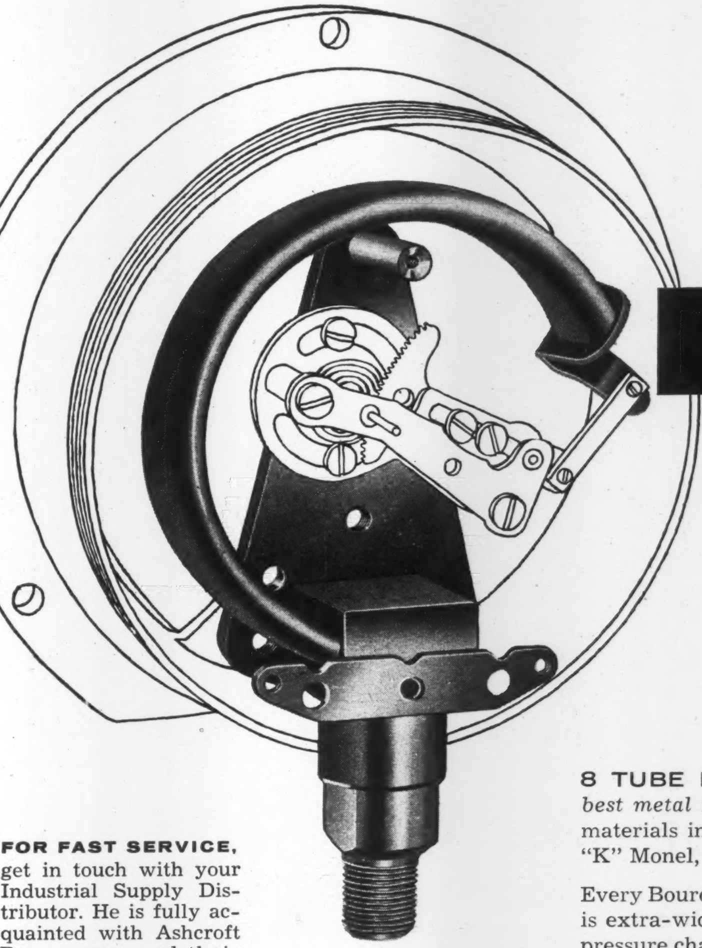
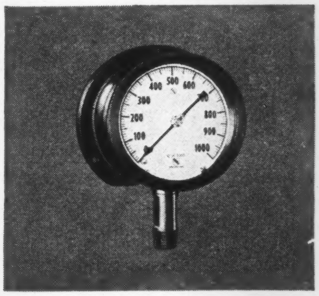


Why does the BOURDON TUBE in the ASHCROFT DURAGAUGE insure sustained accuracy?

FOR FAST SERVICE, get in touch with your Industrial Supply Distributor. He is fully acquainted with Ashcroft Duragauges and their proper selection for all kinds of applications.

8 TUBE MATERIALS permit selection of the *best metal* for particular service conditions. These materials include phosphor bronze, alloy steels, "K" Monel, stainless steels, and beryllium copper.

Every Bourdon tube used in the Ashcroft Duragauge is extra-wide – highly sensitive to slight pressure changes. Socket and tip joints are welded or brazed, then stress relieved after assembly, to assure maximum safety and uniform structure for highest corrosion resistance and strength. Each tube assembly is "whip tested" at pulsating pressures approximately 50% higher than its pressure rating to insure calibration stability.



The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A choice of case designs and materials, dial sizes and pressure ranges readily satisfy the most exacting requirements. Whatever the working pressures or corrosive conditions of your operations, specify Ashcroft Duragauges and be sure of highest sustained accuracy and long service life.

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MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES *Muskegon, Mich.*

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NOW!
QUICK-EASY SELECTION

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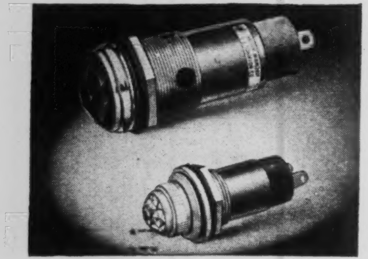
PILOT LIGHTS



For "in the field" replacement or original equipment manufacture, you'll find that it's easier and faster to specify Johnson Panel Indicators. Available in a wide variety of types, Johnson "preferred" units are immediately available at parts distributors throughout the country. Careful standardization, with an eye to replacement as well as interchangeability, makes Johnson Pilot Lights the first choice of many leading manufacturers.

Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass and lucite jewels in clear, red, green, amber, blue, or opal lenses. Specials, including those meeting military specifications are also available in production quantities. For full information write today!

NEW CATALOG! Covers complete Pilot Light Line—write for your copy today!

SOLDERLESS NYLON CONNECTORS

Available in 11 bright colors. Shockproof nylon sleeves won't chip or crack with hardest usage. Excellent for high voltage applications. Highly resistant to extremes of heat, cold, and moisture. Tip and banana plugs designed for simplified solderless connection of up to 16 gauge stranded wire — jacks require soldered connection. Simple, functional design gives top quality at low cost.

Write for samples, prices, and further information.

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For more information circle **111** on inquiry card.

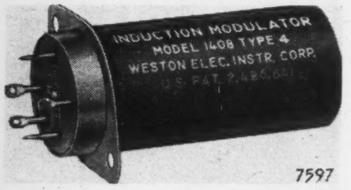
of each tube provides easy access to all signal connections, is detachable from 'scope assembly, can be rotated by hand to horizontally adjust relative position of tube trace to plastic grid even when 'scope is fully assembled and in operation. Each tube has before it an edge-illuminated calibrated plastic grid with its own brightness control, also a bezel for mounting a camera. "Multiscopes" use high-precision flat-face Du Mont 3" CRT's. High voltage power supply and positioning control supply are electronically regulated so that position of the trace is not affected by ordinary line voltage changes.—*Tinker & Rasor, San Gabriel, Calif.*

For more information circle **456** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

DC-AC CONVERTER

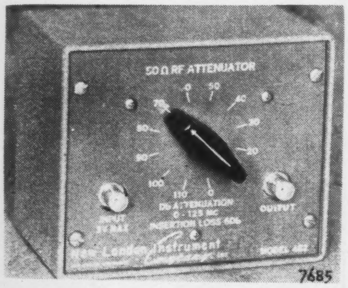
New "Induction Modulator" has no contacts; operates on a new principle; differs radically from choppers and other transducers. It comprises a permanent-magnet moving-coil mechanism whose coil is positioned by dc signal input through it. Field coils mounted on this movement's magnets induce an alternating voltage in moving coil proportional to its position as determined by dc signal input. Output wave form is sinoidal. Conversion gain is about 28 db. Capacitors can be used to make output in quadrature with input if desired. Device is hermetically-sealed, operable in any position, suitable for airborne equipment. —*Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.*



For more information circle **457** on inquiry card.

LADDER-TYPE ATTENUATOR

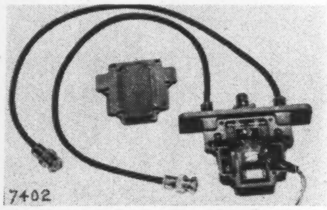
New "Model 462," for use in production tests as well as in high-precision lab work, provides up to 110 db of attenuation from dc to 125 Mc; is unusual in combining a 5-step 20-db ladder network with a 10-db pi network, this 10-db section being automatically switched in or out by front-panel control to provide 10-db steps. Attenuation accuracy 0.5 db; output vswr less than 1.2 to 1; leakage practically nil.—*New London Instrument Co., 82 Union St., New London, Conn.*



For more information circle **458** on inquiry card.

COAXIAL CHOPPERS

New coaxial choppers are for high-speed switching of radio signals at no loss. All switching circuits are designed in coaxial sections for low loss. Frequencies up to 440 Mc can be switched with less than 2½ to 1 vswr. Models are available in dp-dt and sp-dt. Switch can be operated from dc to 150 cps.—*James Vibrapowr Co., 4050 North Rockwell St., Chicago 18, Ill.*



For more information circle **459** on inquiry card.

CALIBRATOR FOR PICKUPS

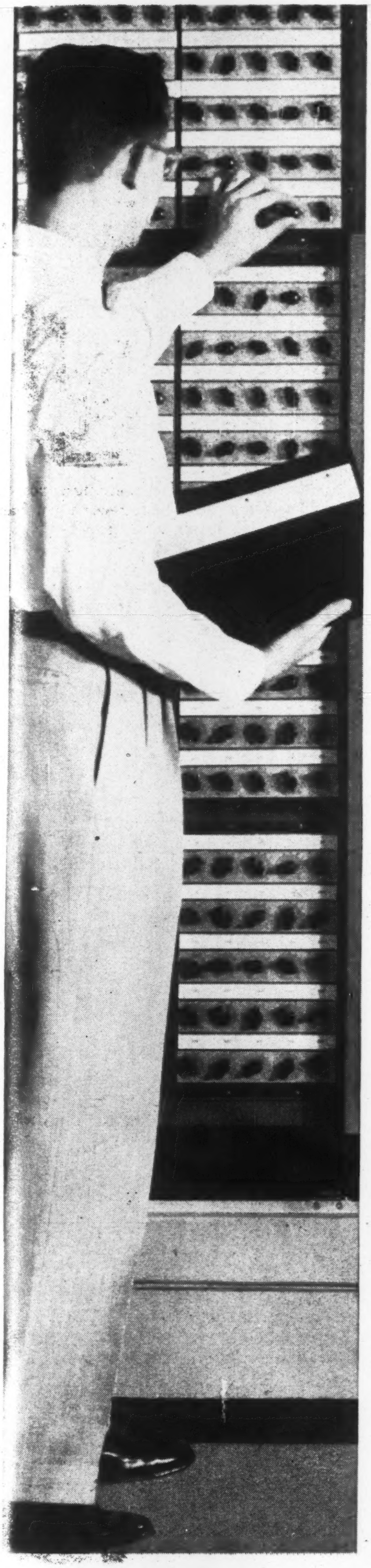
New "Type C Calibrator," for calibration of strain-gage pickups, their transmitters and thermocouples, is accurate to 0.05%; will calibrate one- two- or four-arm systems without complicated special hook-ups; employs electrical equivalent method of calibration; makes dead-weight testing necessary only once for each pickup transmitter. Furthermore, all loads applied to a pickup are read directly in force, acceleration, torque, pressure, etc., and usual arithmetic is eliminated in a linearity check.—*Allegany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Maryland.*

CALIBRATOR
TYPE C

For more information circle **460** on inquiry card

VERNIER CAPACITOR

New "V-Cap" vernier capacitor, though specifically designed for computer applications, is recommended for any application where a 0.1 to 1-



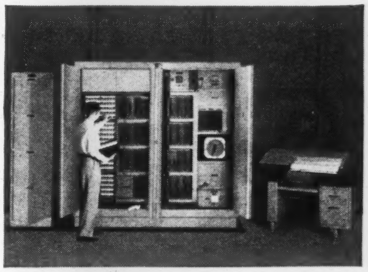
Panalog Information Systems guide management in raising plant output and profit

Panalog 605 Information System supplies management control information. Now, operating personnel and management can receive organized digital information on any process, instantly and continuously. Information can be presented in a variety of forms for immediate control action as well as for engineering and accounting analysis. A typical presentation method employs an electric typewriter and patented log chart. Readout can also be made on punched or magnetic tape, punched cards, or can be fed directly to computers.

Periodically logs and continuously scans. A precision servo measuring system quantizes process variables during automatic, periodic logging. A high-speed electronic measuring system detects off-normal conditions during continuous scanning of all variables. Normal and return-to-normal values are printed in black—off-normals in red. A complete log of all variables as well as a summary of off-normals can be made at any time.

Completely flexible and expandable. Panalog components are standardized, packaged modules. The system can be easily expanded or modified in the field. The Panalog 605 is sufficiently flexible to supply digital information for any management requirement.

Write for literature. Literature presenting a comprehensive treatment of the Panalog 605 is available. If you wish, a Panellit representative in your area will be happy to discuss the possibilities that a Panalog Information System offers your company.



Full scale, adjustable, high and low off-normal limits are provided for each input variable. Basic system capacity, 200 points with one electric typewriter — can be expanded. Accuracy, ±.25% of full scale range. Logging speed, approximately one line per minute. Scanning speed, five points per second, between logs.

Logged values are grouped by processing unit on chart. Audio-visual alarms accompany detection of off-normals. When scanning, off-normal values are identified and printed in separate chart area. Totalized and averaged values as well as plant efficiencies can be automatically computed and recorded by the system.

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Instrument Services Division

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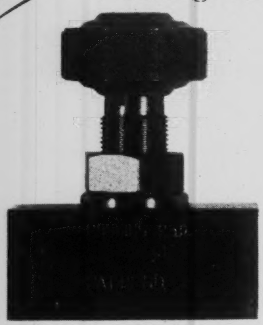
Panellit of Canada Ltd., Toronto 14

For more information circle **112** on inquiry card.

ROBBINS Leakproof Metering Valves



- Hi Vacuum to 6000 PSI.
- "O" Rings and Teflon or Nylon Seats are standard.
- Over-torquing cannot damage seat or needle as buffer plate and metering pin act as a forming die.
- Impossible to score needle or seat.
- Lifetime Valve—can be completely overhauled in a matter of minutes without disturbing plumbing or mounting.
- The most economical valve in the long run.

Write for further details.

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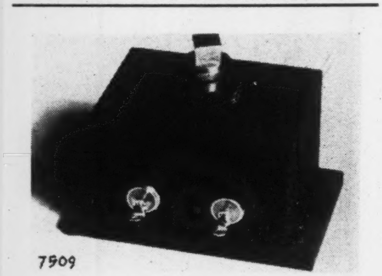


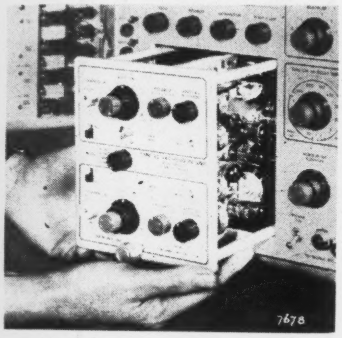
mfd capacitor must be adjusted to an accuracy of better than 0.05%. Users report stabilities better than 0.01%. Dielectric absorption and insulation resistance is almost undetectable (10^{14} ohms). Dissipation factor is 0.0005.—*Balco Research Labs., 49-53 Edison Pl., Newark, N. J.*

For more information circle **461** on inquiry card.

AMPLIFIERS

DUAL-TRACE PREAMPLIFIER

New "Type 53/54C" fast-rise dual-trace unit is interchangeable among all maker's "530 and 540 Series" oscilloscopes. Two identical amplifier channels can be operated independently or electronically switched either by 'scope sweep or at a free-running rate of about 100 kc.—*Tektronix, Inc., P.O. Box 831, Portland 7, Oregon*



For more information circle **462** on inquiry card.

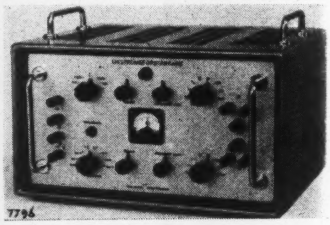
LINEAR AMPLIFIER

New "RLI-1" is a high-gain (8000) linear amplifier with excellent overload characteristics. Pulse rise time is 0.25 usec; output noise is less than 1 v peak-to-peak when amplifier is operating at maximum gain settings. In addition to good linearity (better than 1%) and high signal output level (to 120 v), amplifier has excellent overload characteristics: when subjected to a 1-usec input signal whose amplitude is 100 times that necessary to drive amplifier to full output, no ringing, double-pulsing or base-line shift is observed.—*Tracerlab, Inc., 130 High St., Boston 10, Mass.*

For more information circle **463** on inquiry card.

DC AMPLIFIER

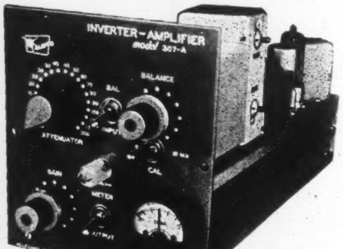
New "Universal Two-channel" dc amplifier (Swedish-made) can be used as a voltage amplifier and as a power amplifier with enough power to drive magnetic-pen recorders; has differential input and single output. Gain max. 700, min. 0.2. Eight accurate (1%) voltage ranges for calibration, from 30 mv to 100 v.—*Oltronix, 235 Underwood Drive, Atlanta 5, Georgia.*



For more information circle **464** on inquiry card.

GALVANOMETER AMPLIFIER

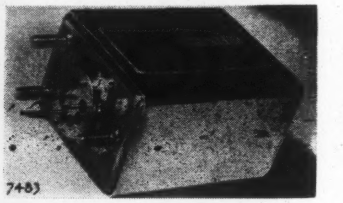
New "Model 307-A" low-drift dc amplifier for use with wire strain gages, thermocouples, etc., will drive most galvanometers (including low-sensitivity high-frequency types); provides excellent linearity over a wide range of input voltages; is trouble-free.—*Allegany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Maryland.*



For more information circle **465** on inquiry card.

SERVO AMPLIFIERS

New "Model 1800-0100" is a miniaturized hermetically-sealed plug-in transistor servo amplifier primarily



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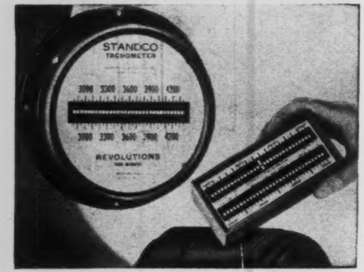

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For more information circle **117** on inquiry card.

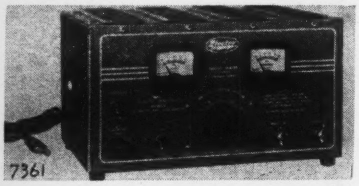
intended to receive signals from a synchro control transformer and to operate a Kearfott "Type 422185" servomotor or equivalent. It meets MIL-E-5400.—*M. Ten Bosch, Inc., Pleasantville, N. Y.*

For more information circle **466** on inquiry card.

POWER SUPPLIES, etc.

TRANSISTOR-RADIO TEST POWER SUPPLY

New "Model D 612 T" dc power supply, reportedly "the first in the field designed to operate, test and service transistor auto radios," operates on ac input and handles 6/12-v tube radios as well as transistor models. Among innovations is a new filter circuit that keeps ac ripple below critical level for testing of transistor auto radios.—*Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.*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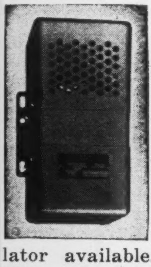
For more information circle **467** on inquiry card.

VOLTAGE REGULATORS

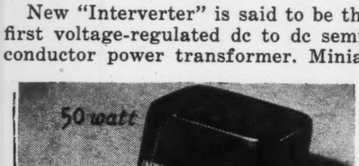


Newly redesigned "Type CVH Harmonic-Neutralized Constant Voltage Transformers" feature smaller size, lighter weight, and greatly-reduced external field: "far lower than any other stock, static-magnetic voltage regulator available." Available in 250-, 500- and 1000-va capacities.—*Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.*

For more information circle **468** on inquiry card.

DC-TO-DC SEMICONDUCTOR POWER TRANSFORMER

New "Interverter" is said to be the first voltage-regulated dc to dc semiconductor power transformer. Miniature, standard, and high-power series are available, ranging from ¾ watt to 1 kw. Efficiencies up to 90%. Dc input voltage of 1.5 to 60. "Almost any" output voltage, with regulation up to 0.1%. Many advantages over conventional rotating converters.—*The Interelectronics Corp., 2432 Grand Concourse, New York 58, N. Y.*

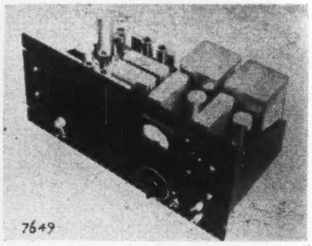


7250

For more information circle **469** on inquiry card.

PRECISION AC SUPPLIES

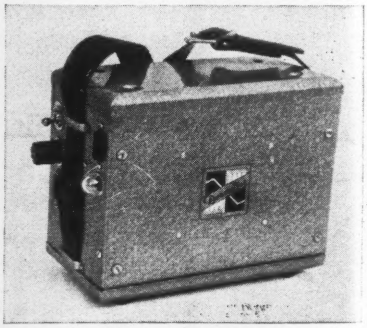
New precision power converters for instrumentation are designed to supply 117 vac at extremely accurate output frequencies, for geophysical recording equipment, etc. Models are available for 12 or 24 vdc input. Frequency outputs available are 50, 60 or 100 cps, all with accuracy of one part per million.—*James Vibrapower Co., 4050 North Rockwell St., Chicago 18, Ill.*


7649

For more information circle **470** on inquiry card.

PORTABLE 115-VAC SUPPLY

New "Model DY-1012 Portable A.C. Power Pack" weighs 9½ lbs; delivers 115 volts, 60 cps plus or minus 1 cps, from its self-contained "Lifetime Dynaseal" battery. Built-in charging device completely recharges the battery when required. Battery will produce 50 watts of 115 vac for about 50 min and 75 watts for 3 min before recharging.—*Dynaseal Lighting Corp., 5 Hadley Street Cambridge 40, Mass.*

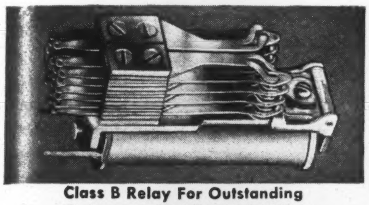


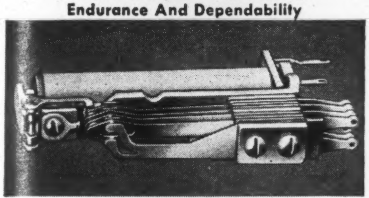
For more information circle **471** on inquiry card

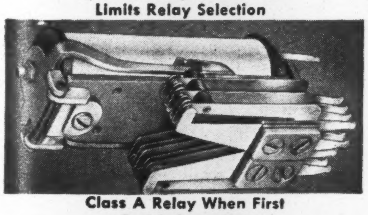
80 KW POWER SUPPLY

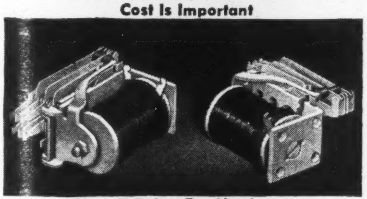
New completely self-contained supply, designed for powering pulse-modulator section of HV pulse test sta

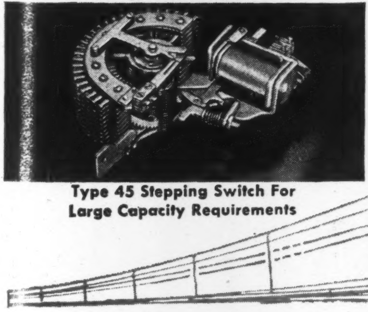
. . . an industry serving industry-


Class B Relay For Outstanding Endurance And Dependability


Class C Relay Where Size Limits Relay Selection


Class A Relay When First Cost Is Important


Class Z Relay For Maximum Timing With Reduced Size


Type 45 Stepping Switch For Large Capacity Requirements

Of all the dial telephones now in service throughout the world, over two-thirds operate on the principles which Automatic Electric originated and developed... In addition to its service to the telephone industry, Automatic Electric has for many years offered communication and electrical control equipment to *all* industry.

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Built to the exacting standards of the telephone industry, Automatic Electric relays and switches are vital components of many electrical and electronic devices. Available in scores of basic types, each with numerous varieties of coil and contact combinations to meet any electrical control need. These Automatic Electric components are finding innumerable uses in industry.

For further information on Automatic Electric's P-A-X Business Telephone Systems or on Relays and Switches for Industrial Control, write: Automatic Electric Sales Corporation, 1033 W. Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto 16.

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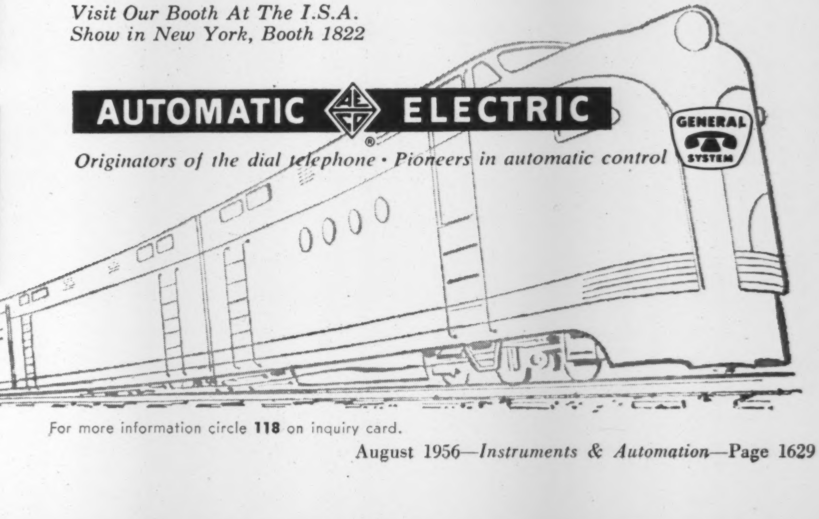

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GENERAL SYSTEM

For more information circle **118** on inquiry card.

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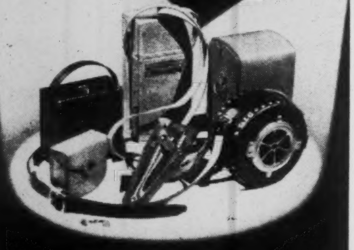

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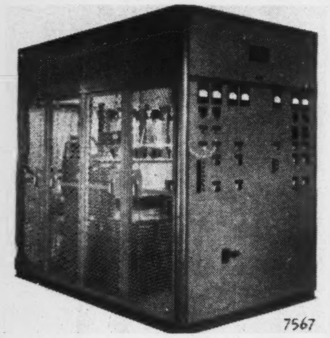


7567

tions, delivers up to 20 kvdc output at 4 amp with less than 1% ripple; operates from a 208-v 3-phase 60-cps input source and provides a regulated continuously-variable output from zero to maximum rating. Numerous automatic protection devices.—*Dep't M, Manson Laboratories, 207 Greenwich Ave., Stamford, Conn.*

For more information circle **472** on inquiry card.

30-KV 30-KW SUPPLY

New power supply developed as part of MTI radar system provides up to 30,000 vdc at less than 0.05% ripple; more than 30 kw of dc power from a 3-phase 208-v 50/60-cps input. —*Levinthal Electronic Products, Inc., 2905 Fair Oaks Ave., Redwood City, Calif.*

For more information circle **473** on inquiry card.

RECTIFIERS

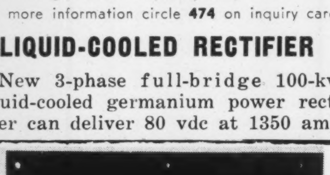
SELENIUM RECTIFIER CELLS

New high-current-density selenium rectifiers, almost 50% smaller and lighter than conventional selenium stacks of equivalent ratings, are for TV receiver applications; operate safely at higher voltages and temperatures than before. Aging is negligible.—*Federal Telephone & Radio Co., 100 Kingsland Rd., Clifton, N. J.*

For more information circle **474** on inquiry card.

LIQUID-COOLED RECTIFIER

New 3-phase full-bridge 100-kw liquid-cooled germanium power rectifier can deliver 80 vdc at 1350 amp with a maximum input of 66 vdc and about 1150 amp ac and with rectifier efficiencies to 98.4%. Superior cooling, with flow rate of 4 gpm (for water). —*International Rectifier Corp; El Segundo, Calif.*



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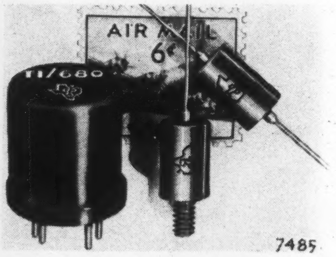
For more information circle **475** on inquiry card.

1500-V SINGLE JUNCTION SILICON RECTIFIERS

Five production types of radically new silicon rectifiers feature a single grown junction element with 1500-volt breakdown voltage, stable operation up to 150°C and forward current ratings up to 100 ma; obviate need for filament power; are immediately available in two types of axial and stud half-wave models and a full-wave plug-in model, all hermetically sealed.—*Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas.*



7485

For more information circle **476** on inquiry card.

SILICON RECTIFIERS

New 800- to 1000-v pigtail types of silicon power rectifiers (left), and new group of stud-mounted units (right), are said to make maker's line "the most complete line of medium power silicon rectifiers yet available commercially." Now 22 different types in eight voltage ranges, all immediately available in production quantities.—*Automatic Mfg. Div., General Instrument Corp., 65 Gouverneur St., Newark 4, N. J.*

7380

For more information circle **477** on inquiry card.

FIXED RESISTORS

MINIATURE POWER RESISTOR

New miniature precision silicon-sealed ceramic shell type resistor passes humidity and salt-spray military tests; is claimed to be "ideal for terminal board or printed circuit mounting." Ceramic shell offers uniform outer dimensions and is unaffected by

7458

How to Control Heat in a Large Oven

No. 4 of a series — *Showing the Broad Application Range of Fenwal Controls*

The oven is designed to dry 30 yards of finished goods per minute at oven temperatures up to 400°F. The problem was to maintain the desired 330°F in the oven. Here's how this was accomplished —

The many electric heaters, which are distributed uniformly in the oven, provide a total heat input of about 60,000 watts and are divided into two separate control circuits. About one-third of the heaters are controlled by a simple on-off controller of moderate sensitivity to maintain a basic heat level in the oven. The remaining heaters are operated by the Fenwal Series 560 Portable Temperature Indicating Controller, an instrument of high sensitivity and rugged construction. The Series 560 provides the proportioned heat necessary for accurate control of the curing process. It also can be used for straight on-off control. Here's the way the control set-up works —

To maintain the desired 330°F in the oven, the on-off controller is set at 315°F, while the proportioning controller is set at 330°F. So both heater circuits are on during oven warm-up or when incoming fabric depresses the oven temperature below 315°F. Above 315°F, the on-off controller shuts off the heaters in its circuit, and the process heat is obtained from the remaining heaters under the control of the Fenwal Series 560 Controller.

THIS 600 CUBIC FOOT CURING OVEN, planned and installed by Atlas Textile Machinery Co., Paterson, N. J. at the Gsell Textile Printing Corp. plant in New York, uses the Fenwal Series 560 Portable Temperature Indicating Controller to provide uniform drying conditions within 2 degrees of the set point.

Integrated Sensitivity a Big Advantage in The Series 560

In the Fenwal Series 560 Temperature Indicating Controller the superior thermoelectric qualities of the revolutionary thermistor are used to fullest advantage. The great resistance change of the thermistor in response to temperature change results in extreme sensitivity. It also enables the use of a simple null balance bridge circuit for increased stability. And it permits the use of a standard electric conductor as a connecting wire — *no special wire is required.*

These characteristics have been *integrated* by Fenwal into a rugged, durable instrument which is the first to combine all three major modes of indicating control — on-off, proportional and adjustable differential — *all functioning with high sensitivity at the flip of a switch.*

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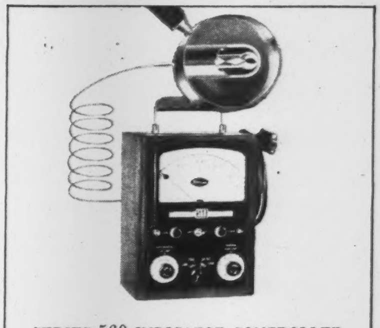
Fenwal Sales Representatives and Engineers have saved time, trouble and money in all types of plants and laboratories by solving thousands of temperature control and detection problems. Fenwal THERMOSWITCH® units are controlling processes that involve liquids, gases and solids.

Put Fenwal's vast reservoir of technical know-how to work for you. Chances are your problem has already been met and mastered by Fenwal engineers. Write for Catalog No. 500 for complete information.



SERIES 560 INDICATOR CONTROLLER with magnified cutaway view of thermistor probe.

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- CONDUCTANCE — 1 Micromho to 1 MHO
- "Q" — 0.5 to 100
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For more information circle 123 on inquiry card.

abrasion and rough handling. Available in values from 0.1 to 55,000 ohms; tolerance 5% to 0.05%; exceeds MIL R-26B characteristic "G" specs. —*Reon Resistor Corp., 117 Stanley Ave., Yonkers, N. Y.*

For more information circle **478** on inquiry card.

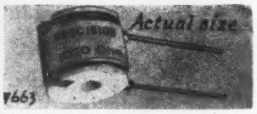
PRECISION RESISTOR

New "NS-6AV" subminiature encapsulated precision resistor, designed to meet MIL R-93 Characteristic A, measures 0.150" dia, 3/8" long. A new method of mechanically attaching axial leads to winding form eliminates possibility of leads being pulled out during use; also allows for "a much greater winding area." Values up to 500,000 ohms; tolerance as close as 0.01%.—*Eastern Precision Resistor Corp. 677 Barbey St., Brooklyn, N. Y.*

For more information circle **479** on inquiry card.

FINE-TOLERANCE RESISTORS

New "Precise-Ohm AW and BW" resistors meet MIL-R-93A. "AW" is rated at 0.25 watt; "BW" at 0.5 watt. Tolerances of 1%, 0.5%, 0.25% and 0.1% are standard; 0.05% and

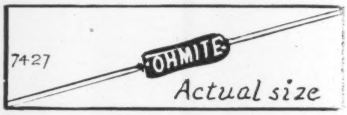


0.02% can be obtained. Both types are non-inductively wound. In applications such as analog computers or bridge networks, these types can be matched to 0.02%.—*Precision, Inc., 730 Lyndale Ave. North, Minneapolis, Minn.*

For more information circle **480** on inquiry card.

3-WATT RESISTORS

New 3-watt axial-lead vitreous-enameled resistor is available from stock in resistance values from 1 to



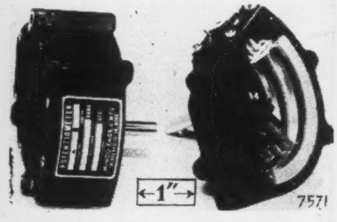
10,000 ohms; is especially suited for printed circuits, terminal board, and point-to-point wiring applications. All parts are "thermally balanced," so as to expand and contract as a unit.—*Ohmite Mfg. Co., 3677 Howard St., Skokie, Illinois.*

For more information circle **481** on inquiry card.

VOLTAGE-DIVIDING RESISTORS

ROTARY-SECTOR VDR

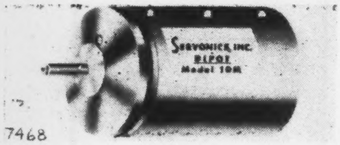
New rotary-sector voltage-dividing resistor, especially adapted to flight test, servo feedback and telemetering applications, is designed to withstand up to 40 lbs side load on its shaft while operating; is gasket and O-ring sealed against immersion to 15 psi; has dual element (4800 ohms each element); up to 2 watts dissipation per element; 110° active travel, 5° overtravel each end; resolution 1/17°. —*Minco Engineering and Mfg., 801 8th St., S.E., Minneapolis 14, Minn.*



For more information circle **482** on inquiry card.

HIGH-PRECISION VDR

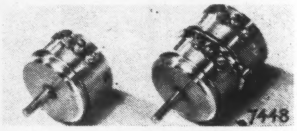
New "Dipot" 2"-dia voltage-dividing resistor features linearity of 0.005% (terminal), extended frequency limits without phase shift, and other mechanical and electrical advantages. It makes use of a double Kelvin-Varley circuit (automatized to give a continuous precisely linear voltage division) and depends on matched resistors instead of a helical coil for linearity. It is available in a 5- or 10-turn units.—*Servonics, Inc., 834 N. Henry St., Alexandria, Va.*



For more information circle **483** on inquiry card.

PRECISION VDRs

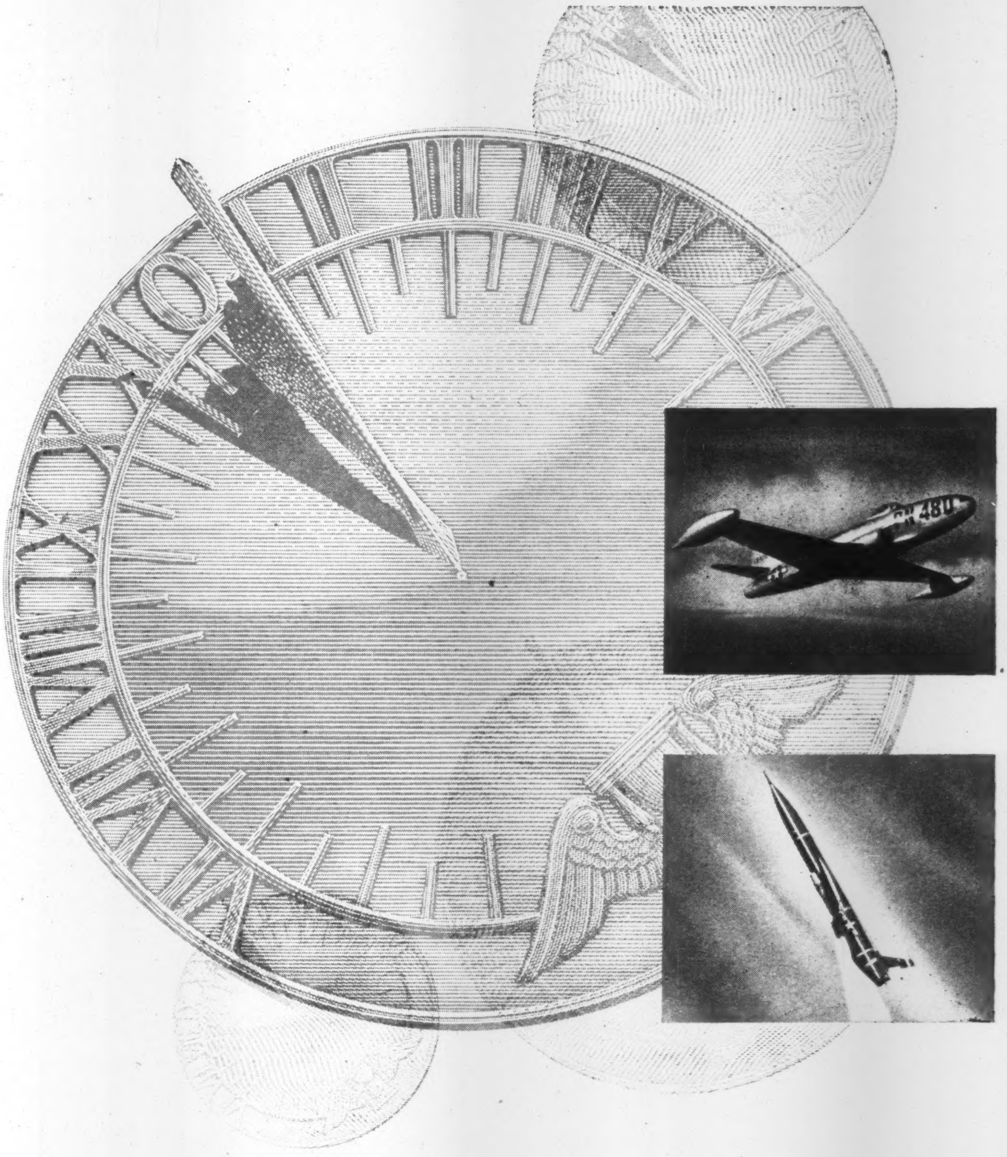
New "Ultra-precise" line, of voltage-dividing resistors includes all sizes from ½" to 3" OD. Bases are of aluminum alloy, gold-anodized per AN-QQ-A696a. Stainless steel clamp rings permit easy phasing and secure clamping of ganged units. Radial shaft play 0.0003" max; concentricity 0.0003" T.I.R. Temperature range —50°C to 125°C. Units have been built to operate for 50,000,000 cycles at 3000 rpm.—*Precision Line, Inc., 63 Main St., Maynard, Mass.*



For more information circle **484** on inquiry card.

WIRE-WOUND VDR

New "X-500 Acepot" sub-miniature voltage-dividing resistor operates in temperature range from —55°C to



MEETING A DECADE OF CHALLENGES

From the P-80 Shooting Star to missile star shooting, the past ten years of technological advancement presented many challenges to the Avionics industry and G. M. Giannini & Co., Inc.

Now, with a wealth of engineering experience and increased production facilities, Giannini is looking forward—with confidence—to meeting a new decade of even more exacting challenges.

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For more information circle **124** on inquiry card.

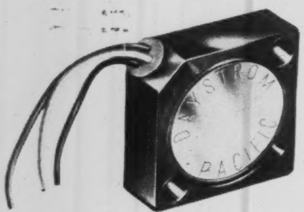
NEW INSTRUMENTS

150°C; offers features, characteristics, and dependability of regular-size units. Resistance range 200 ohms to 250,000 ohms 2%; Linearity 0.3%; size ½"; weight ¼ oz; available in threaded bushing, servo, flush tapped hole, or flange mountings and up to 6-gang units.—*Ace Electronics Associates, 103 Dover St., Somerville 44, Mass.*

For more information circle **485** on inquiry card.

TRIMMING VDR

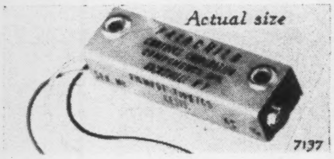
New "Model 303-00 Miniature Trimming Potentiometer" is "big brother" of maker's subminiature "300-00" but "bigness" is concentrated mainly in resistance capacities. It offers a broader range of resistance values—from 25,000 to 100,000 ohms. Dimensions: 0.75" square by 0.28" thick. Geared adjustment ratio assures exact wire-to-wire contact between resistance element and precious-metal slider. Any number of units can be stacked together.—*Daystrom Pacific Corp., 3030 Nebraska Ave., Santa Monica, Calif.*



For more information circle **486** on inquiry card.

TRIMMER VDR

New "FilmPot" variable voltage-dividing resistor features "Nobl-Ohm" precious-metal film resistance element; provides infinite resolution throughout 28½-turn adjustment-screw travel. Operating temperature range −57°C to 125°C. Linearity 5% for resistance values from 50 to 25,000 ohms.—*Components Div., Fairchild Controls Corp., 225 Park Ave., Hicksville, N. Y.*



For more information circle **487** on inquiry card.

SEALED TRIMMING VDR

New "Trimpot Model 230" sealed trimming voltage-dividing resistor is designed to meet or exceed military humidity Specs; will operate at 135°C and dissipate 0.4 watt at 50°C. It is screwdriver-adjusted over 25 turns; has self-locking shaft.—*Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.*

Bourns Trimpot

For more information circle **488** on inquiry card.

CAPACITORS

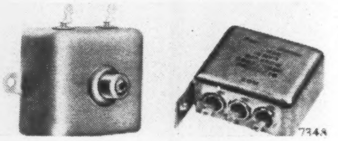
TANTALUM CAPACITORS

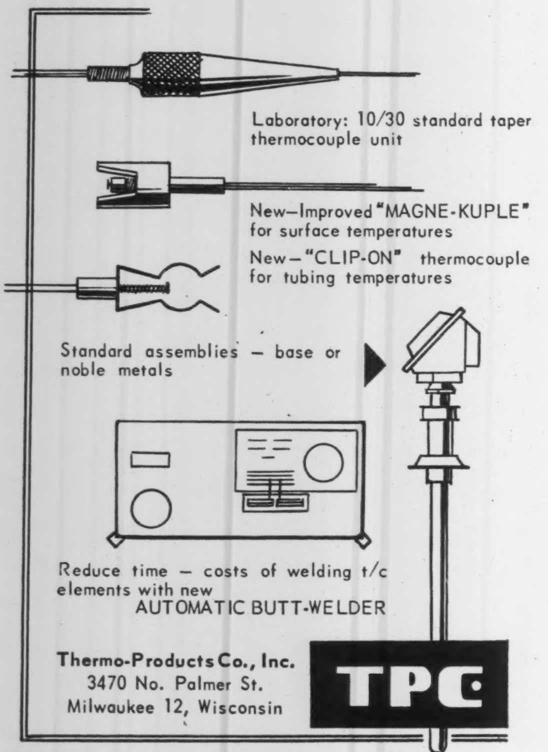
New "Series TW Ohmite Tan-O-Mite" subminiature capacitors for transistorized equipment are more stable, have greater capacitance in a given size, and are usable over a wider temperature range than aluminum electrolytic capacitors.—*Ohmite Mfg. Co., 3625 Howard St., Skokie, Ill.*

For more information circle **489** on inquiry card.

POLYSTYRENE CAPACITORS

New line of polystyrene dielectric capacitors includes fixed and adjustable value types encased in metal




Laboratory: 10/30 standard taper thermocouple unit

New–Improved "MAGNE-KUPLE" for surface temperatures

New–"CLIP-ON" thermocouple for tubing temperatures

Standard assemblies – base or noble metals

Reduce time – costs of welding t/c elements with new AUTOMATIC BUTT-WELDER

Thermo-Products Co., Inc.
3470 No. Palmer St.
Milwaukee 12, Wisconsin

TPC

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EQUIPMENT LASTS LONGER . . . PERFORMS BETTER . . .

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INLET
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LASTS LONGER because . . .
The Aridifier's patented centrifugal-baffle action traps 92% of all dirt, oil, scale and water in gas or compressed air . . . and drains off these troublemakers *before* they can damage tools and equipment.

PERFORMS BETTER because . . .
The Aridifier protects tools against the freezing, fouling, caking and corrosion caused by dirt and foreign matter . . . assures the clean, dry air and gas that means better spray work, painting, lacquering, sand blasting, air cleaning, and similar operations.

Easily installed, the Aridifier maintains itself. 10 models. Capacity range; 7 CFM to 17,000 CFM.

Learn HOW the Aridifier scrubs with a patented centrifugal-baffle action. **Write for This Catalog Now!**

Logan ENGINEERING CO.
4921 W. Lawrence Ave., Chicago 30, Ill.

For more information circle **126** on inquiry card.

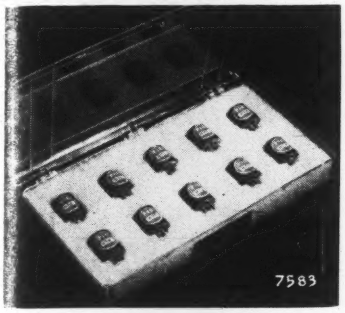
"bath-tub" type cans, designed principally for computer field. Adjustable-value type (left) has added advantage of a fixed value which can be adjusted plus or minus 1½% even after capacitor has been installed in circuit. This is accomplished by means of an Allen head set screw. Available in capacitance range from 0.5 to 10 microfarads; 100, 200 or 400 vdc; normal tolerance 1% of nominal value.—*Condenser Products Co., 140 Hamilton St., New Haven, Conn.*

For more information circle **490** on inquiry card.

ELECTRONIC COMPONENTS

PULSE TRANSFORMER KIT

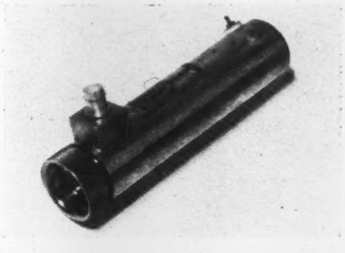
New "P 10 H" pulse transformer kit designed especially for transistor circuit design contains ten different plug-in types affording a wide selection of ratio and open circuit inductance. Pulse widths from less than 0.2 usec to more than 100 usec.—*Polyphase Instrument Co., 701 Haverford Rd., Bryn Mawr, Pa.*


7583

For more information circle **491** on inquiry card.

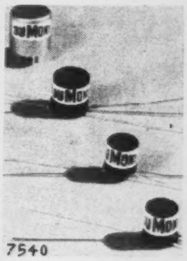
BEACON CAVITY OSCILLATOR

New "Model 193 Rocket Tube Cavity Oscillator" features small size (5½" L) and light weight, whence suitability for aircraft, guided missile and beacon applications. It employs Sylvania UHF planar triode; has a single control for tuning; utilizes fixed feedback; is available for frequencies from 2500 to 4000 Mc, with a tuning range of 200 Mc.—*Amerac, Inc., 116 Topsfield Road, Wenham, Mass.*



For more information circle **492** on inquiry card.

PULSE TRANSFORMERS

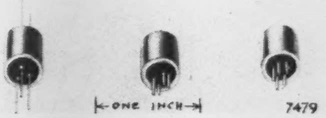

7540

New complete line of miniature and subminiature pulse transformers features extremely fast rise times and exceptionally high duty cycles. Some of them have been operated at repetition rates of 5 to 6 Mc and it is possible to obtain up to 40% duty cycle without backswing. Typical examples (left to right): "Type 22136" blocking oscillator and coupling transformer, plug-in and encapsulated models, each weighing ¼ oz; and two coupling transformers, "Types 22127 and 22128," each weighing ⅛ oz.—*Allen B. Du Mont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.*

For more infomration circle **493** on inquiry card.

PULSE TRANSFORMERS

New subminiature pulse transformers meet all the performance requirements of so-called "miniature" series widely used in computers and military electronics at no increase in cost



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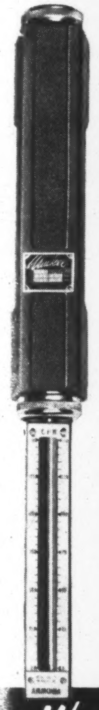


cleaned and back at work in 5 minutes

Waukee FLO·METER

The Waukee FLO-METER can be cleaned and back in operation in five minutes *or less!* Saves time and money.

Inherent accuracy of the FLO-METER is protected by Waukee's design for fast, easy cleaning. No tools are needed. Production interruption at a minimum.

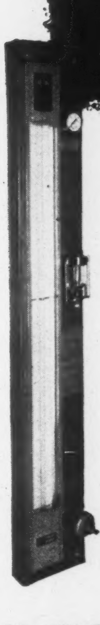
The Waukee FLO-METER also features: built-in Control Valves, panel mounting, simple piping, large 6" and 9" scales for ease of reading. Capacities 3 CFH to 10,000 CFH.

Complete information in Bulletin 203. Write for it. **Waukee Engineering Company,** 5137 North 35th Street, Milwaukee 9, Wisconsin.

For measuring: air — ammonia — dissociated ammonia — argon — butane — city gas — endothermic cracked — exothermic cracked — forming gas — helium — hydrogen — natural gas — nitrogen — oxygen — propane.

Waukee FLO-METERS • AIR-GAS MIXORS INDUSTRIAL WASHING MACHINES

For more information circle **11** on inquiry card.



Petrometer SERIES 1400 LIQUID DEPTH GAUGES

ACCURATE and EASY TO INSTALL

Available in 4 Models, Petrometer Series 1400 Tank Gauges operate on the sound principle of hydrostatic pressure. No moving parts, no expensive electrical or electronic equipment. Large vertical scale gives accurate, easy-to-see reading. And construction features make installation easy.

For complete information send for Bulletin 6004

Petrometer CORPORATION
43-22 TENTH ST., LONG ISLAND CITY 1, N. Y.

For more information circle **127** on inquiry card.

over larger types; are furnished in single- and double-ended constructions, for use with printed wiring boards and conventional assemblies, respectively.—*Sprague Electric Co., 401 Marshall St., North Adams, Mass.*

For more information circle **494** on inquiry card.

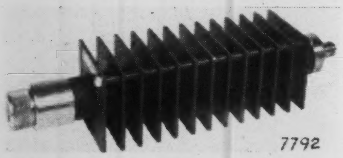
CERAMIC MOUNT FOR SILICON POWER RECTIFIERS

New compact ceramic mount improves performance of silicon power rectifiers; electrically insulates rectifier so as to permit its use at high potentials above ground. Heat conduction is several times more efficient than with conventional mounting methods. Mounts can be supplied threaded to accept any standard semiconductor power diode.—*Ceramic Sales, Raytheon Mfg. Co., Waltham 54, Mass.*

For more information circle **495** on inquiry card.

COAXIAL POWER PAD

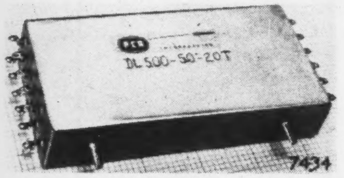
New "Model 528" is rated 30 watt, 34.8 db, dc to 600 Mc, 50-ohm impedance type-N connectors, used to extend 10-mw frequency sensitivity range of commercial powermeters to 30w. Power sensitivity (change of attenuation) is less than 0.1 db/w.—*Weinschel Engrg. & Mfg. Corp., 10503 Metropolitan Ave., Kensington, Md.*



For more information circle **496** on inquiry card.

MULTI-TAPPED DELAY LINES

New custom built, hermetically-sealed, multi-tapped delay lines utilize a metal case 5" long x 2½" wide x 1" high. Obtainable internal electrical characteristics are said to be "unlimited." A typical line can be obtained with a delay time of 5 usec tapped at 0.25, with a characteristic impedance of 500 ohms.—*PCA Electronics Inc., 2180 Colorado Ave., Santa Monica, Calif.*



For more information circle **497** on inquiry card.

MEDIUM-MU TRIODE

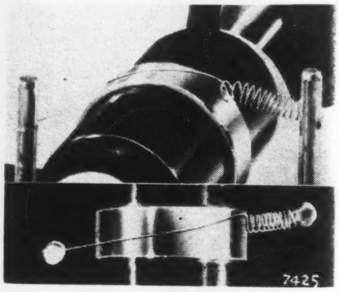
New "6829" 9-pin miniature medium-mu twin triode for airborne computers is first of a new line which combines high reliability design features of maker's "5-Star line" with special design characteristics of maker's standard computer tubes; has same electrical ratings as the "5965" and in addition must pass high reliability tests for stability, survival, heater-cycling, shock and fatigue. It has an altitute rating of 60,000 ft and withstands impact acceleration of 450 *G* and vibrational acceleration of 2.5 *G—Tube Dep't, General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **498** on inquiry card.

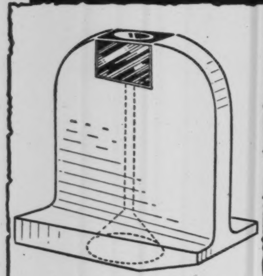
ELECTROMECHANICAL COMPONENTS

SLIP-RING BRUSH

New slip-ring brush has shown life better than 100 million revolutions at low electrical noise level; comprises a self-contained spring and



Sapphire Wire Guide Outwears Steel 14 to 1 and is Still in use at AMERICAN MACHINE AND FOUNDRY COMPANY . . . .



3 Times Actual Size
Wire Size .... .007
Orifice .... .013

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Advantages of Sapphire in This Application

- Resistance to wear from wire friction.
- Smoothness—did not damage or remove the baked-on enamel wire insulation. Sapphire is a homogeneous, single crystal. Surfaces are free from "grain" where wear can start. Freedom from grain also allows the smooth finish necessary to protect wire insulation.

The sapphire insert wire guide shown here is from a stator winding device at American Machine and Foundry Company in Greenwich, Connecticut.

Spectacular Performance

"Sapphire has given us a fine solution to our problem", says our customer. "With the rectangular sapphire insert, one nozzle has passed 41,000 yards of wire and is still operating. Previous to sapphire inserts the longest nozzle wear was 3,000 yards of wire, with a steel nozzle treated to surface hardness of 72 Rockwell C."

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Send us your friction and wear problems for analysis by our engineering staff—no charge of course. Write also for brochure of A. M. Gatti Sapphire Products.

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"Precision Sapphire Products Miniature Sub-Assemblies"

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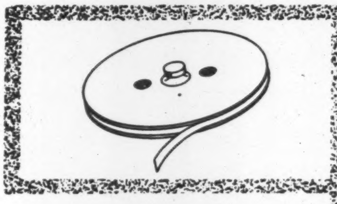
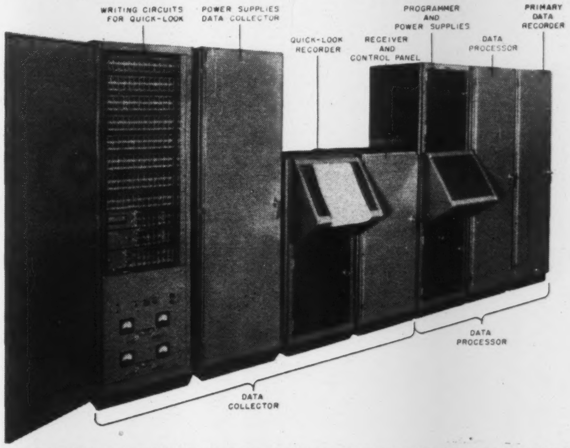


DIGITAL COMPUTER DATA PROCESSING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This digital system provides:

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BRASS
CARBORUNDUM
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COPPER
*CORNING 707
*CORNING 7052
FERRITE
FERROX
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GERMANIUM
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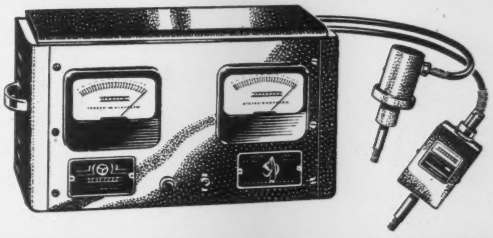
COLD CATHODE HIGH VACUUM MEASUREMENT



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These unique features make the Model VII outstanding for severe industrial use:

- **Can be exposed to air without damage**
- **Wide range: 1 mm. to 10^{-7} mm.**
- **Independent measurements on 2 gauges if desired**
- **Highly stable operation**
- **Simplified construction for easy cleaning**
- **All high-voltage connections fully enclosed**

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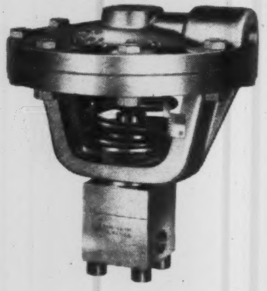
See Your Packless "Demi" Valves assembled and tested, Booths 411-412

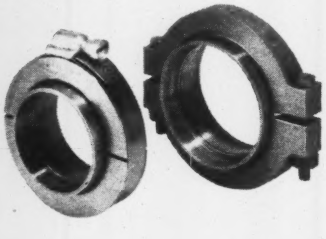
International Instrument Automation Conference & Exhibit, New York Coliseum, Sept. 17-21, 1956

MINIATURIZATION

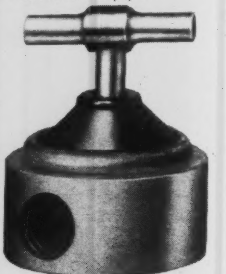
From Pilot Plant to Process



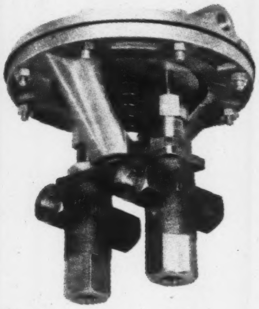
"BANTAM" 500 SERIES
Throttling "Bantam" Diaphragm Control Valves for all standard control valve uses, Cv of 0.6 and below, up to 1000 psi and 500°F, characterized, renewable trim, 316 stainless steel and teflon only wetted surfaces, low in hysteresis, size and weight, a modern design of control valve. 2000 series "Bantam" Control Valves available for on-off service.



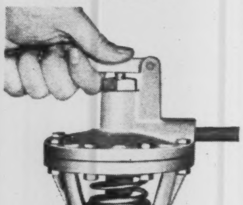
TUBE AND PIPE CONNECTORS
For use in such systems as aircraft or marine applications where weight is a factor, these connectors replace standard flanges. Available in various materials, in male or female socket or butt weld design, for tubing, and up to schedule 40 pipe.



"DEMI" PACKLESS VALVES
For services when packing is a problem, manifolding of small valves in one unit, these low cost valves have a great popularity. For services up to 1500 psi and 500°F., screw, toggle, or diaphragm operated, the "Demi" line is ideal for panel mounting up to five valves in one block.



WHIFFLETREE OPERATOR
Two valves operated simultaneously by one operator. Valves may be globe or three-way and have a multitude of piping arrangements for mixing and routing applications.



MANUAL RESET
Wherever control air on dangerous or toxic process flows must be blocked for safety, on air failure until manually reset, these valves insure against disaster. Standard sizes ¼" and ½" I.P.S.

SAUNDERS VALVES — AIR OPERATED
Plastic valves, 2" and below, metal valves 1" and below, G. W. Dahl Company, Inc. diaphragm operators on these valves provide simple, sure automatic operation. Each application must submit full flow information.

Write us for complete technical information, or the address of our representative in your area.

George W. DAHL Company
BRISTOL, RHODE ISLAND

For more information circle **133** on inquiry card.

wire which contacts slip-ring over a sector of about 180°. (Other tests are now in progress in which a sector of 80° is contacted.)—*The J. M. Ney Co.*, 107 *Elm St., Hartford* 1, *Conn.*

For more information circle **499** on inquiry card.

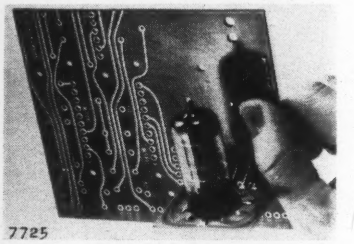
HOOK-UP WIRES

New "Permacode" hook-up wires, insulated with extruded du Pont Teflon suitable for continuous operation up to 210°C, are available in fifteen solid colors and any combination of two, three or four colors. Insulating material comes in both solid and striped colors; provides inherently permanent coding, a significant advance in striping technique. Available in nominal 0.010" or 0.015" wall thicknesses; meet MIL-W-16878/A, types E and EE.—*Revere Corp. of America, Wallingford, Conn.*

For more information circle **500** on inquiry card.

ANGLE SOCKET

New angle socket provides for mounting tubes in units where there is limited height, and for maintenance and servicing accessibility where circuit boards are plugged vertically into larger units or terminal strips; features extreme structural rigidity; cannot be bent out of position or torn from circuit board.—*Cleveland Metal Specialties*, 1783 *East* 21*st St., Cleveland* 14, *Ohio.*



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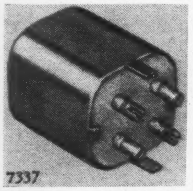
For more information circle **501** on inquiry card.

SHIELDED COIL FORM



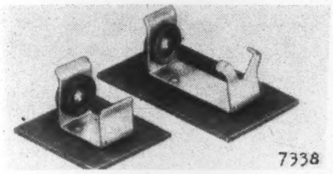
7337

New "LS-12" shielded coil form for printed circuits has a ½" cube plated brass housing, inside which is a coil form with an internally adjustable powdered iron core, tunable from top or bottom. Unit mounts by two tabs that can be inserted through a printed circuit board and can be dip-soldered from one side of board to complete installation. Equipped with two to six terminals, it covers a wide range of applications from simple RF for use with conventional vacuum-tube circuitry to IF transformer using transistors. Units are available as forms alone or wound to customer specs.—*Cambridge Thermionic Corporation*, 445 *Concord Avenue, Cambridge* 38, *Mass.*

For more information circle **502** on inquiry card.

BATTERY CLIPS

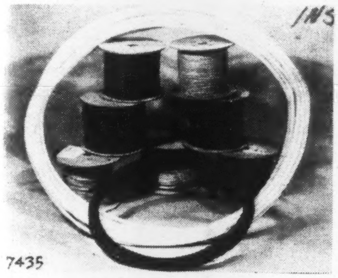
Two new silver-plated phosphor-bronze battery clips for use with transistorized circuitry are said to combine a number of characteristics not heretofore found in such clips; lock simply, yet stand up and remain secure under extremely rough handling; feature positive low-resistance contact. Silver plating resists corrosion even under battery leakage.—*Cambridge Thermionic Corp., Cambridge, Mass.*


7338

For more information circle **503** on inquiry card.

SPAGHETTI TUBING

New spaghetti tubing made from Teflon can be made in various colors for identification; has good dielectric strength (500 to 1000 volts/mil); lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric; no change of electrical properties with temperature (−100°C to 250°C) or frequency (60 cps to 100 Mc); is not affected by moisture. Available in many sizes and styles.—*Pennsylvania Fluorocarbon Co., Inc., 1115 N. 38th St., Philadelphia 4, Pa.*



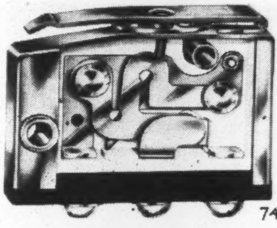
7435

For more information circle **504** on inquiry card.

SWITCHES

LIMIT SWITCH

New "Klixon KX4 Hermetically Sealed Sine Switch" is a snap-action limit switch designed for use in industrial controls, aircraft, and other applications requiring complete operational freedom from all environ-


7476

W&T ABSOLUTE PRESSURE INDICATOR FA-160
ABSOLUTE PRESSURE
MILLIMETERS OF MERCURY
SERIAL NO.
MODEL NO. FA 160
WALLACE & TIERNAN BELLEVILLE, NEW JERSEY
6" dial
2¾" dial
Measures pressure from ZERO ABSOLUTE to Atmospheric

ABSOLUTE PRESSURE INDICATOR

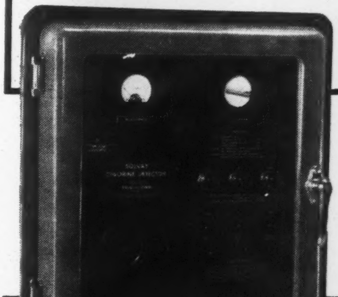
. . . For Precise Vacuum Work

Accuracy: 1/300 of full scale
Sensitivity: 1/500 in *all* ranges
Ranges: 0-50mm Hg. 0-100mm Hg.
0-200mm Hg. 0-410mm Hg.
0-800mm Hg. 390-800mm Hg.
Dial Sizes: 2¾" or 6" diameter for all ranges

Write for Publication No. TP-28-A

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto
A-108

HOW TO DETECT 3 PARTS CHLORINE IN A MILLION PARTS AIR



New W&T Solvay Chlorine Detector*

detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.

Write for Publication 50.118

WALLACE & TIERNAN
INCORPORATED
25 MAIN ST., BELLEVILLE 9, N. J.

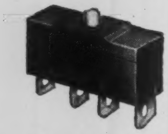
I-55 *Manufactured under patent license from Solvay Process Div., Allied Chemical & Dye Corp.

For more information circle **134** on inquiry card.

mental conditions. Metal diaphragm and special epoxy embedment technique insures complete seal even at high altitudes. Operation is unaffected by shock as high as 200 G and vibration of 40 G, 0-500 cps.—*Spencer Thermostat Div., Metals & Controls Corp.,* 34 *Forest St., Attleboro, Mass.*

For more information circle **505** on inquiry card.

SUBMINIATURE SWITCHES

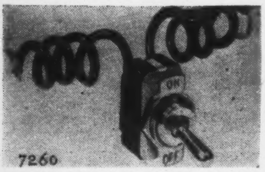


New "BM-12,000 Series" subminiature snap-action switches combines extremely small size with high current-carrying capacity (10 amp at 115 or 230 vac or 28 vdc inductive load); will operate in temperatures as high as 350° F and as low as −100°F in controlled atmosphere; have four terminals for wiring double circuits where required; can be adapted to any present type of actuator.—*Acro Mfg. Co., Columbus* 16, *Ohio.*

For more information circle **506** on inquiry card.

MOMENTARY-CONTACT SWITCH

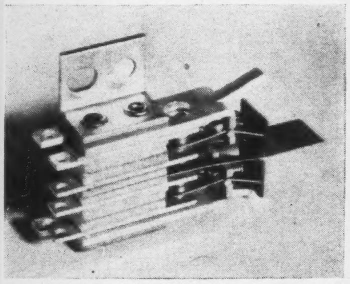
New momentary contact toggle switch is available in two models, rated for 6 amp at 125 v or 3 amp at 250 v. "Model 13" is normally-off trigger-on; "Model 14" is normally-on trigger-off. Both are available with screw terminals, lead wires, or solder-ing lugs.—*McGill Mfg. Co., Electrical Div., Valparaiso, Ind.*



For more information circle **507** on inquiry card.

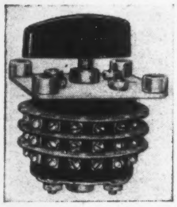
LIMIT OR S&S SWITCH

New "S35-00" simultaneous-action dp-dt basic switch utilizes unique "stored-energy" principle to provide simultaneous action of both poles. Switch functions include limiting, starting & stopping, reversing, etc. —*Cherry Electrical Products Corp.,* 1658 *Deerfield Rd., Highland Park, Ill.*



For more information circle **508** on inquiry card.

ROTARY MULTIPOLE SWITCH



New "Type HT" rotary multipole switch has 16 contact positions per section, twice as many contact positions per pole as previous switches of enclosed type; is designed for tap, transfer and selector service requiring interrupting rating up to 5 amp at 125 vac. Make and break of switching action is fully enclosed within molded phenolic structure of each section. Switch will carry 10 amp at 125 vac. Required panel area is 3" x 3".—*Electro Switch Corp., Weymouth* 88, *Mass.*

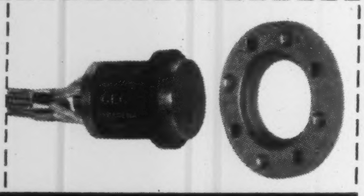
For more information circle **509** on inquiry card

RELAYS

SUBMINIATURE RELAY

New two-pole hermetically-sealed subminiature relay featuring positive adjustment of contact and plunger travel features new design eliminating so-called blind assembly "for the first time in production of relays." Final adjustment of contact and plunger travel after enclosing can has been put into place is accomplished by use of a tiny screw-like attachment

accurate pressure measurement at 600° F



CEC 4-316 PRESSURE PICKUP

Newest of CEC's "4-300" pressure pickups, the 4-316 provides accurate, dependable operation at the elevated temperatures of jet and rocket research and supersonic flight testing. It employs the unbonded-strain-gage principal with special internal construction that ensures hundreds of hours of accurate service at ambient temperatures as high as 600°F— the highest operating range of any standard pressure pickup on the market today.

PRESSURE RANGES... gage and differential from 15 to 150 psi

COMPENSATED TEMPERATURE RANGE... +75°F to 600°F (operable from −100°F to 650°F without damage)

SENSITIVITY... 20 mv f.s. (±10 mv f.s. for differential units)

EXCITATION... 5 v d-c or a-c rms @ 0-20 kc

LINEARITY AND HYSTERESIS... less than 1% f.s.

INPUT/OUTPUT IMPEDANCE... 350 ohms

CABLING... 30" insulated, coded, 4-conductor, permanent cable.

SIZE... ½" dia., ¾" length, nominal

Complete calibration certificate with every unit. Send for Pickup Bulletin CEC 1568–X10.

Consolidated Electrodynamics
CORPORATION
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ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
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OPTICAL COATING OCLI LABORATORY, INC.

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OCLI'S display of coatings will include
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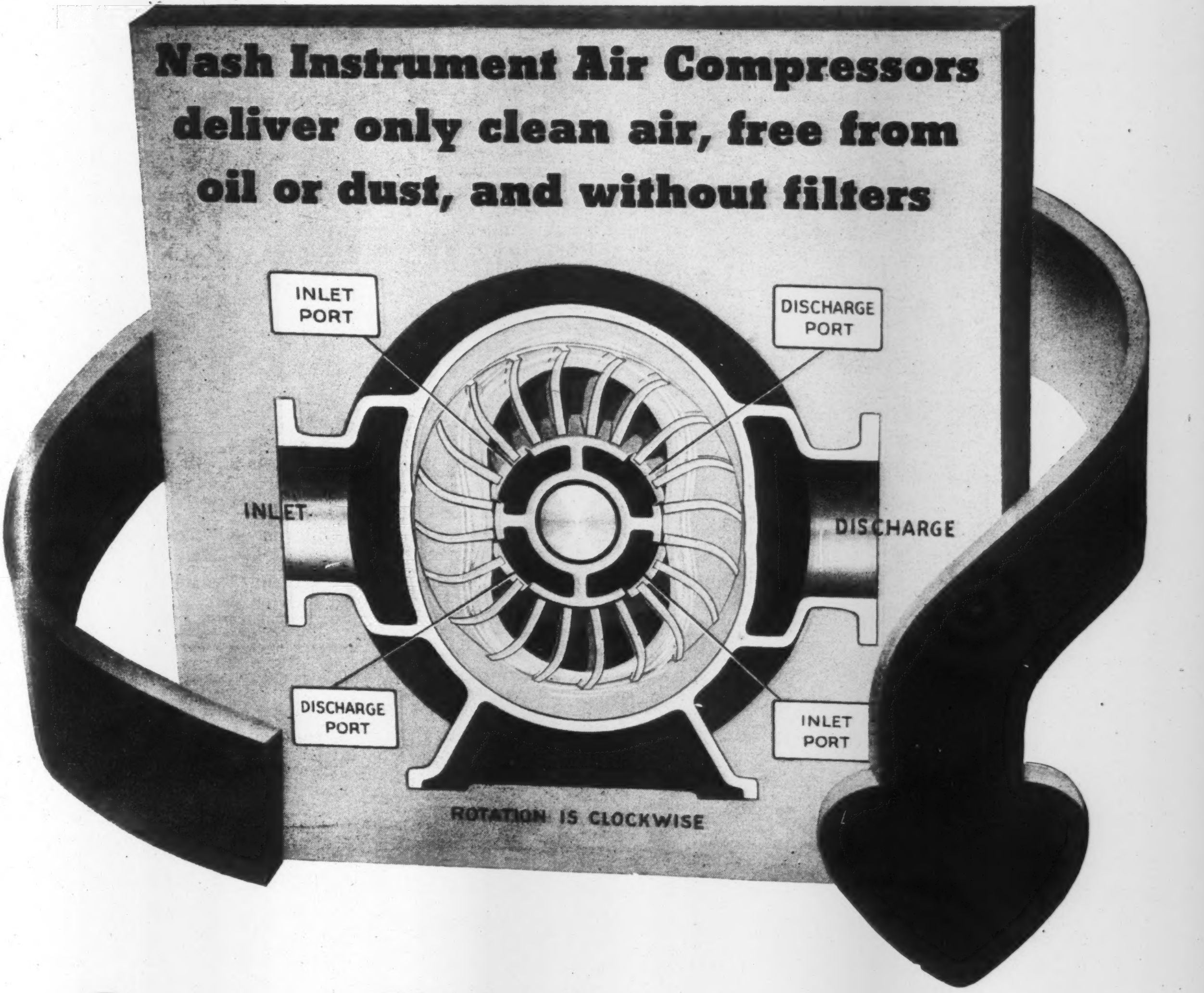

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
INLET
DISCHARGE
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

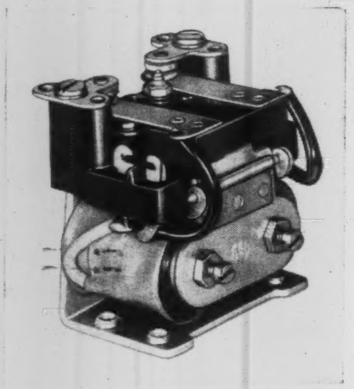
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

which extends outside can from end of relay, making possible final adjustment from outside. Contact rating 2 amp resistive load at 28 vdc or 115 vac.—*Specialty Control Dep't, General Electric Co., Schenectady 5, N. Y.*

For more information circle **510** on inquiry card.

PLATE CIRCUIT RELAY

New "Amrecon Model DOSY" has twin coils which increase its magnetic efficiency (sensitivity). At 115 vac or 32 vdc noninductive load, contact rating is 15 amp. Two dp-dt and two sp-dt types.—*Ohmite Mfg. Co., 3686 Howard St., Skokie, Ill.*



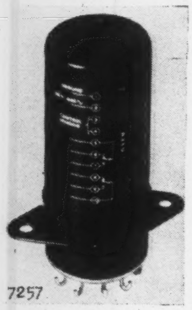
For more information circle **511** on inquiry card.

WIPING-ACTION RELAY

New "Type 100-D," combining a complete wiping action with sensitivity as low as 5 milliwatts per contaot, has "extremely long operating life rated well into the millions." Contact rating 1 amp inductive or 5 amp resistive. Available coil resistance up to 30,000 ohms.—*Hedin Tele-Technical Corp., 87 Dorsa Ave., Livingston, N. J.*

For more information circle **512** on inquiry card.

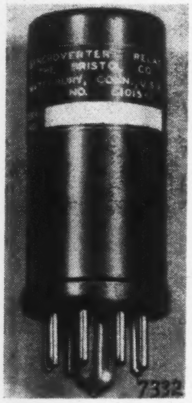
MAG-AMP RELAY



New "Model B-250-1" miniature magnetic amplifier relay weighs 6 oz; has a sensitivity of 80 microwatts for a 0-5,000-ohm source (100 uw for a 15,000-ohm source); operates at temperatures from —55°C to 100°C and at vibration of 10 *G* from 5 to 500 cps.—*The Liquidometer Corp., Skillman Ave. at 36th St., Long Associates, Teterboro, N. J.*

For more information circle **513** on inquiry car

HIGH-SPEED RELAY



New "High-Speed Syncroverter Relay," designed for complete reliability in dry-circuit and low-power applications, is operationally unaffected during shock of 30 G and vibration (10-5 cps) of 10 G Temperatur range —55°C t 100°C; contact ratings up to 2 v 200 ma; pull in time (including bounce) a low as 200 usec.—*The Bristol Company, Waterbury 20, Conn.*

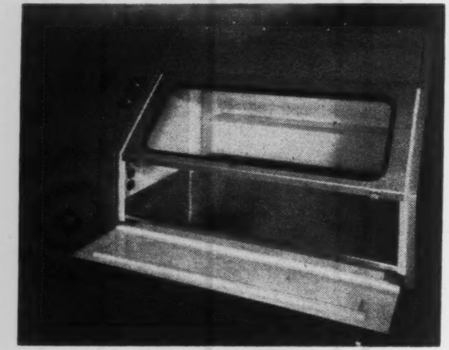
For more information circle **514** on inquiry car

MOTORS, etc.

HAND GENERATOR

New "Mark VII" hand generator guaranteed to last at least four time longer than previous models, meet

STOP using DIRT—
as part of your assembly



NEW MODEL 10 STERILSHIELD CABINET

This dust free work bench is a single, highly portable, self-contained unit for labs, small assembly operations, or field use. Write now:

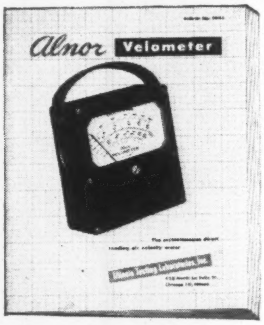
THE BAKER COMPANY, INC.
Maplewood, Maine
"If it has a Bearing on Bearings"

For more information circle **137** on inquiry card.

FREE

ILLUSTRATED BULLETIN

How you can save time by measuring air velocities with an
ALNOR VELOMETER



Developed to facilitate quick and easy determination of air velocities, the Alnor Velometer is a compact, precision instrument that provides instantaneous, direct readings in feet per minute, without timing, calculations or reference to conversion tables. Guaranteed accurate, in ranges from 20 f.p.m. to as high as 24,000 f.p.m. Also available with metric or miles-per-hour calibrations.

Tear out this ad and mail it with your business letterhead to Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

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PRECISION INSTRUMENTS FOR EVERY INDUSTRY

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SPACE MAN... with a Brief Case

Science has a new kind of space man these days. He carries a brief case.

His mission is as new, as exciting and as challenging as a trip to the moon. In many cases you'll find him on the team at Remington Rand Univac®, one of the engineers or technicians who have given UNIVAC the title,

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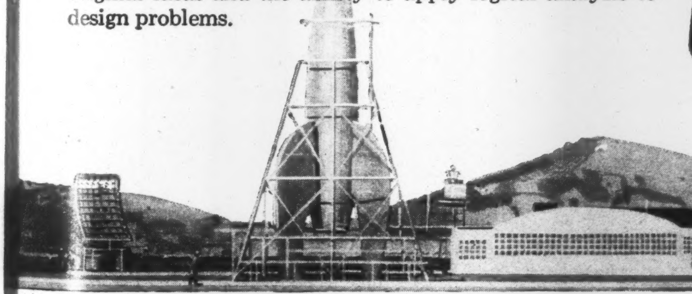
IMMEDIATE OPENINGS FOR:

At South Norwalk we have immediate openings for Mechanical and Electro-Mechanical Engineers with a bachelor's degree in *Engineering*. Extensive mechanical design background may substitute for some college. Men selected will do basic preliminary design and layout of small mechanisms. Work will require the development of original ideas and the ability to apply logical analysis to design problems.



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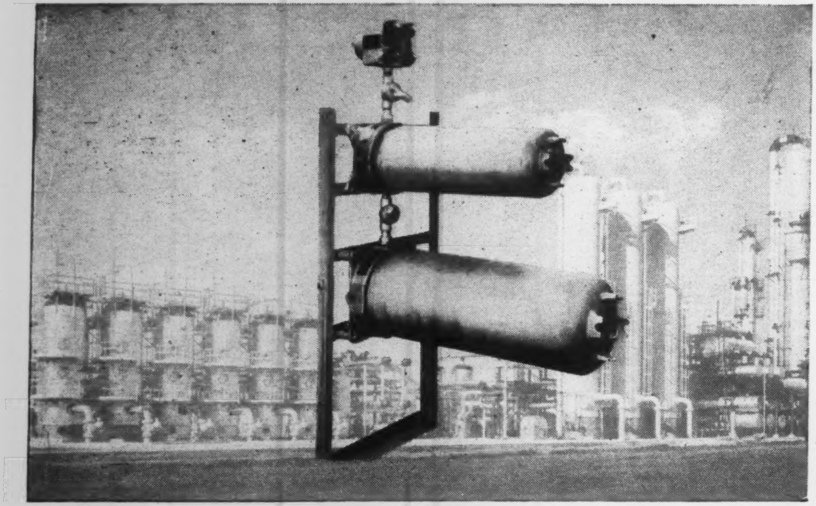


The BICHROMATOR® Infrared Analyzer

Designed for Continuous Gas and Liquid Analysis Under Plant Conditions

Here is the first industrial infrared analyzer based on the proven principles of laboratory spectrometers and used for continuous monitoring and control of chemical processes. The Bichromator Analyzer is a two wave length, dispersion-type instrument, applying base-line density principles of the infrared laboratory to continuous process analysis.

It is an extremely stable and rugged instrument with no moving optical parts. The simple radiation null principle and closed loop servo system insure rapid response, virtual freedom from source or line current variation, or changes in amplifier linearity. This photometric system allows full-scale recorder operation with as little as 3% change in transmission.

The Bichromator Analyzer continuously measures the concentration of one component in an industrial sample. It is set on two wave length intervals; one, unique to the sample being analyzed (the component of interest), the other at a reference wave length where the sample does not absorb radiation. The energy difference at the two wave lengths is proportional to the concentration of the component of interest and can be converted to a measure of the concentration.

Thousands of laboratory infrared spectrometers now in use attest to the accuracy and stability inherent in the design of the dispersion instrument. Furthermore, the performance of the Bichromator Analyzer *can be predicted* from laboratory spectrometer data and tied to present laboratory control procedures.

Check these features

1. Sample cell in separately purgeable compartment outside main instrument for ease of checking without exposing instrument proper to plant atmosphere.
2. Built-in test circuit for rapid, simple instrument checks *in hazardous areas* without need for tools or test equipment.
3. Electronics system features unitized construction with functional subassemblies for simplified servicing.
4. Special by-pass liquid sampling cells designed to give fast response and eliminate sampling lag.
5. Handles unstable or corrosive gases and liquids.
6. Handles hot or cold samples.
7. Interchangeable dispersion units, factory pre-set, for each specific control problem.
8. Field conversion to a new problem is possible.

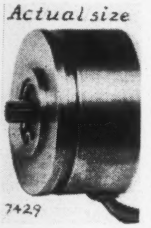
Perkin-Elmer CORPORATION
Norwalk, Connecticut

For more information circle **139** on inquiry card.

requirements of Amendment 2 of MIL-G-11994 (Sig. C); can withstand a maximum of 200,000 operations. At 200 rpm, it produces 20 cps ac at 1.75 watts, open circuit voltage of 95 minimum. It weighs less than 23 oz and is mechanically and electrically interchangeable with other types of hand generators.—*Holtzer-Cabot Telephone Equipment Div., Nationa Pneumatic Co., Inc.,* 125 *Amory St., Boston* 19, *Mass.*

For more information circle **515** on inquiry car

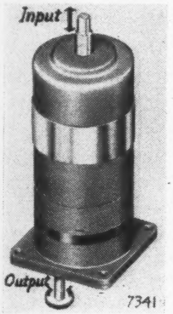
SHORT SERVOMOTOR



New "Type 2V 3362", servomotor, believed to be "by fa the shortest serv ever made," is exactly half the bulk of a 1"L x 1"OD size-1 servo, but it has one-third the torque and half the rotor inerti of size 10. Since torque and rotor inertia factors approximately offset each other and remaining characteristics of both motors are basically similar, smaller motor is "virtually as powerful as a size-1 servo."—*John Oster Mfg. Co., Avionic Div., Racine, Wis.*

For more information circle **516** on inquiry card.

SERVOMECHANISM

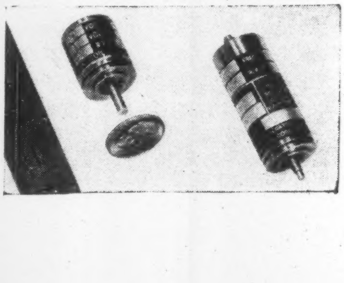


New "Power Transducer" is said to translate lateral force to direction and speed regulation with 200-to-1 mechanical power amplification; is available in a variety of FHP sizes with a wide selection of gear-train assemblies whereby direction and speed of servo can be controlled in proportion to displacement of input shaft.—*Cedar Engineering, Inc.,* 5806 *W.* 36*th Street, Minneapolis* 16, *Minn.*

For more information circle **517** on inquiry card.

"DIME SIZE" SERVO UNITS

New size 8 servomotor and motor-driven induction generator, smallest ever produced for practical application, exhibit characteristics comparable to size 9 models which up to now

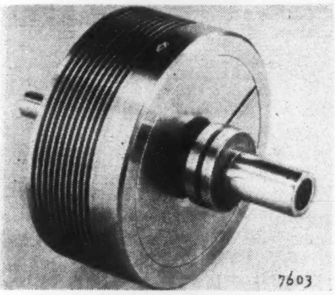


have found wide application as the smallest servo units available. New control motor, for example, is 40% lighter and 10% smaller in diameter than size 9. An all-transistor amplifier has also been developed to power servo combination as a miniature package. When required, maker will also furnish a converter to drive a counter for analog-to-digital conversion.—*Transicoil Corp., Worcester, Pa.*

or more information circle **518** on inquiry card.

HYSTERESIS CLUTCH

New hysteresis clutch provides maximal torque with a minimal control power for applications requiring



proportional torque control. Generated torque is 140 oz-in with input power of 65 ma at 28 vdc. Approx. dimensions 3⅝" OD x 4½"L.—*American Electronics, Inc., 655 West Washington Blvd., Los Angeles 15, Calif.*

or more information circle **519** on inquiry card.

MECHANICAL COMPONENTS

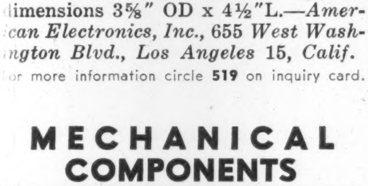
MIL SPEC KNOBS

New complete line of military spec knobs, added to maker's "Blue Chip" components, are molded of Tenite II (LP349 Type 2, class MS) in black matte finish. Anodized aluminum insert of 17ST4, finished ANOQA696, threaded for two cadmium-plated fluted Bristo head set screws. Various cap colors and shapes.—*The National Co., Malden, Mass.*

or more information circle **520** on inquiry card.

DIALS, DIVIDED CIRCLES, ETC.

New dials, divided circles, digital coding discs, sine-wave frequency standards, complex wave-forms, etc., are available in various materials. Example of precision: a small dial with 2160 graduations, each line having a width of exactly three microns (obtained by making 1200



Modern industrial research instruments

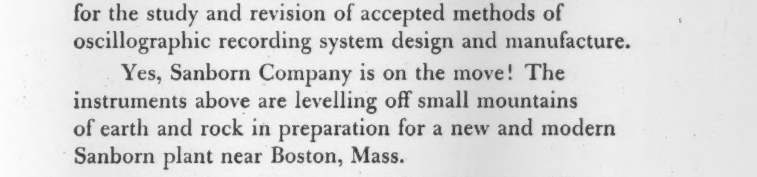
THESE seven-ton bulldozers are truly research tools, for they are taking part in an exhaustive program for the study and revision of accepted methods of oscillographic recording system design and manufacture.

Yes, Sanborn Company is on the move! The instruments above are levelling off small mountains of earth and rock in preparation for a new and modern Sanborn plant near Boston, Mass.

Completion of the structure late this year will mean vastly improved facilities for research, manufacturing and other operations. This will directly and immediately benefit not only the work Sanborn does, but also the people who use Sanborn systems, amplifiers, recorders and other components. It will make possible more rapid development and production of new instruments, and increased opportunity for a larger number of people to apply their skills to the problems of modern instrument design and manufacture.

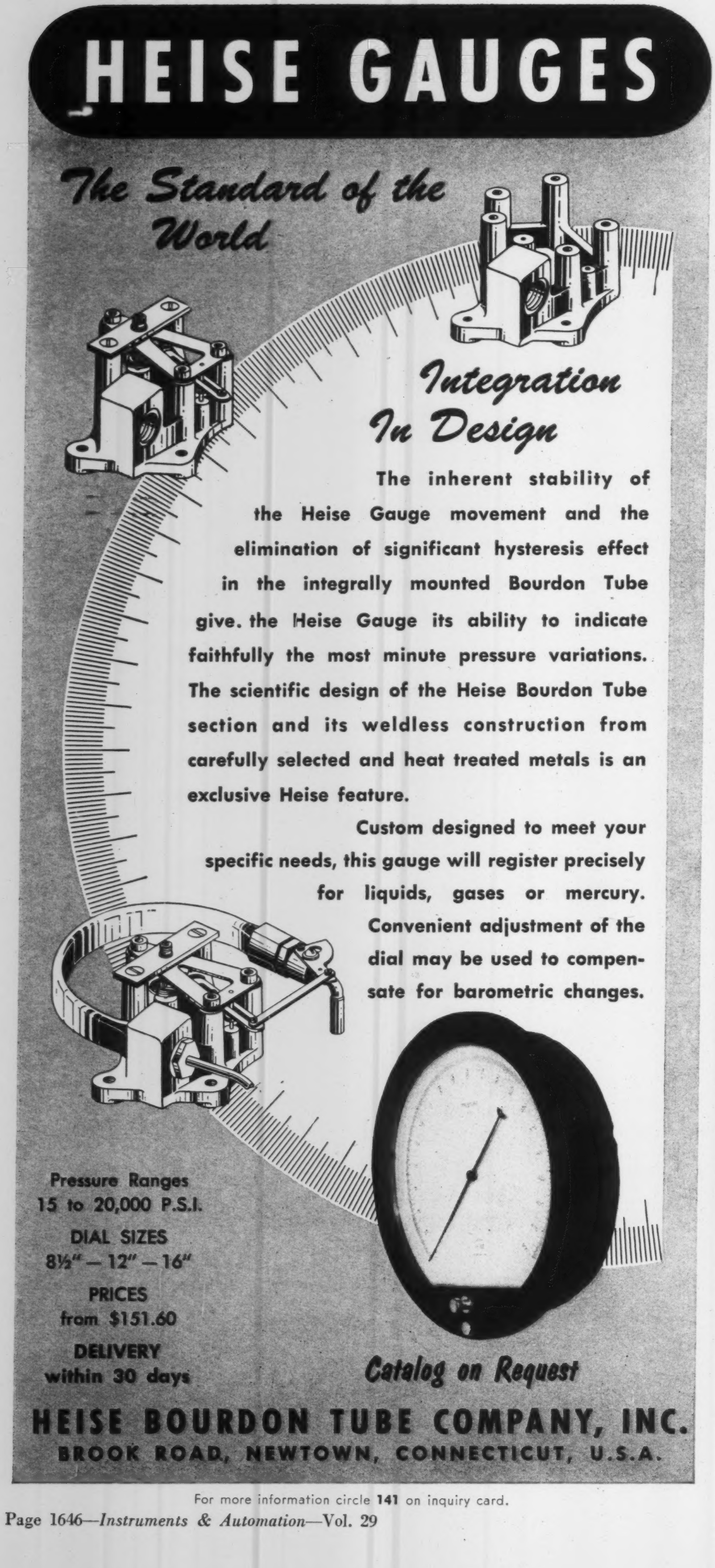
This represents not "just a new plant", but a reflection of Sanborn's growing role in providing better answers to industry's oscillographic recording needs.

Sanborn Company, Industrial Division, Cambridge 39, Mass.



Scale model of new Sanborn plant just off Route 128 in Waltham, Mass.

For more information circle **140** on inquiry card.



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The inherent stability of the Heise Gauge movement and the elimination of significant hysteresis effect in the integrally mounted Bourdon Tube give the Heise Gauge its ability to indicate faithfully the most minute pressure variations. The scientific design of the Heise Bourdon Tube section and its weldless construction from carefully selected and heat treated metals is an exclusive Heise feature.

Custom designed to meet your specific needs, this gauge will register precisely for liquids, gases or mercury. Convenient adjustment of the dial may be used to compensate for barometric changes.

Pressure Ranges
15 to 20,000 P.S.I.
DIAL SIZES
8½" – 12" – 16"
PRICES
from $151.60
DELIVERY
within 30 days

Catalog on Request

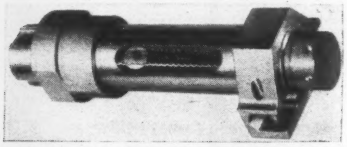
HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle 141 on inquiry card.

exposures for each graduation). Maker's exclusive optical generation process eliminates drafting and photoreduction time.—*Precision Photomechanical Corp., 170 S. Van Brunt St., Englewood, N. J.*

For more information circle **521** on inquiry card.

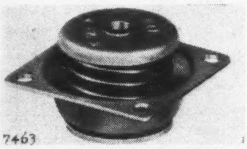
LIQUID SPRING



New "Tension-Compression Liquid Spring" using liquid compressibility, features single piston with double action (push-pull spring action). Housing is 1 5/8" OD by 8 1/2" L. This new model has 1100 lb preload and 11,000 lb endload.—*Taylor Devices, Inc., 188 Main St., North Tonawanda, N. Y.*

For more information circle **522** on inquiry card.

ANTIVIBRATION MOUNT

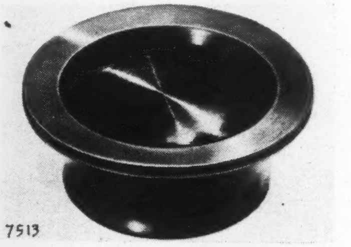


7463

New "K375" all-metal lightweight unit mount, for vibration protection of electrical equipment in jet aircraft and winged missiles, has a low natural frequency (6-9 cps); is readily adaptable to many applications in which outdated mounts of AN8008 type had been used.—*Robinson Aviation, Inc., Teterboro, N. J.*

For more information circle **523** on inquiry card.

PISTON SEAL



7513

New "Class 3 Bellofram" piston seal has been developed for applications where flange parting surfaces must form a metal to metal joint; is a long-stroke deep-convolution constant-area diaphragm which simplifies both design and manufacture of pressure-sealed mechanisms; is available in more than 80 standard sizes, for bores from 1" to 6". Many elastomer-fabric combinations.—*Bellofram Corp., Burlington, Mass.*

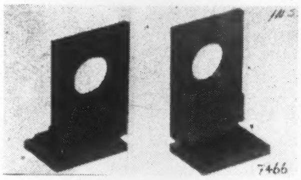
For more information circle **524** on inquiry card.

INSTRUMENT WASHERS

New miniature brass instrument washers include sizes 00, 0, 1 and 2; are completely burr-free. Special sizes are available to order.—*J. I. Morris Co., 394 Elm St., Southbridge, Mass.*
or more information circle **525** on inquiry card.

COMPONENT HANGERS

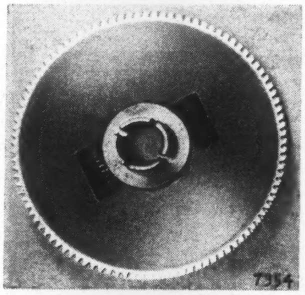
Fourteen new anodized aluminum omponent hangers provide sturdy upport for electrical components;



ave been pre-bored to differing hole iameters (up to 2.750") required to old component; meet requirements or over 165 commercial components. —*Servo Corporation of America, 20-0 Jericho Turnpike, New Hyde Park, .I., N. Y.*
or more information circle **526** on inquiry card.

ANTI-BACKLASH GEARS

New "Anti-Backlash Gear Assemlies" in pitch diameters from 1" to " are available in 14½° or 20° pres-



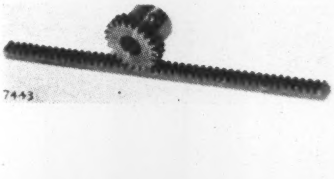
ure angles and in 48-64-72-80-96-or 20 dia pitch. Blanks are 24ST aluminum with choice of Alodine or nodize. Gears are cut to Precision lass I tolerance.—*Dynamic Gear Co.; nc., Amityville, N.Y.*
or more information circle **527** on inquiry card.

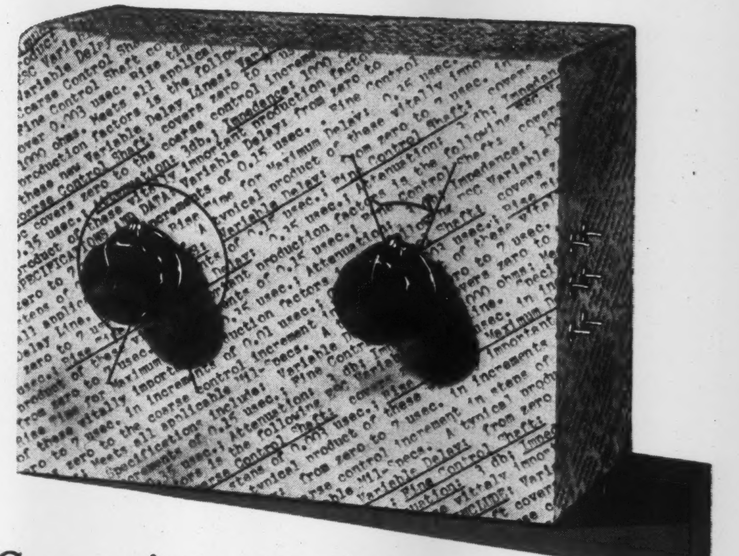
DOWEL PINS

New "Type #D2" precision ground owel pins are available from stock n 1/32", 1/16", 3/32" & ⅛" dia, in engths from 3/32" to ⅞".—*PIC Deign Corp., 160 Atlantic Ave., Lynrook, L. I., N. Y.*
or more information circle **528** on inquiry card.

FINE PITCH RACKS

New "Type AG Precision Fine Pitch Racks" are cut to AGMA Precision 1 tolerances; are available





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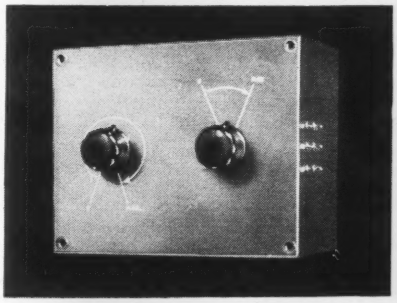
Variable Delay Lines

takes more than just imagination

Experience . . . Flexible Facilities . . . Skilled Personnel . . . These are the ingredients necessary for the accurate translation of your specifications into a design, into the development of a prototype, and eventually, into the the manufacture of VARIABLE DELAY LINES which meet and exceed your requirements.

A typical product of these vitally important production factors is the following ESC Variable Delay Line—specifications include: • *Variable Delay:* from zero to 7 μsec. in increments of 0.01 μsec. • *Coarse Control Shaft:* covers zero to 7 μsec. in increments of 0.15 μsec. • *Fine Control Shaft:* covers zero to the coarse control increment in steps of 0.003 μsec. • *Rise Time for Maximum Delay:* 0.35 μsec. • *Attenuation:* 3 db • *Impedance:* 1000 ohms • Meets all applicable Mil-Specs.



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For more information circle **142** on inquiry card.

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BETWEEN YOUR FINGERS

CURTISS-WRIGHT

DYNAMIC CAPACITOR ELECTROMETER

FOR STABLE AMPLIFICATION OF LOW-LEVEL DC SIGNALS

Measures currents as low as 10^{-16} amp. • Extremely high input impedance . . . 10^{15} ohms. • Low drift — less than ± 1 mv per 24 hours. • Uses dependable, durable dynamic capacitor. • Accuracy of ± ½% full scale. • Only 14″ x 10″ x 9″

The Curtiss-Wright Dynamic Capacitor Electrometer is ideal for measuring minute currents or voltages from high impedance sources. There is no 60 cps interference since the Dynamic Capacitor Electrometer operates at 1,000 cps. The instrument can be used to measure static charges, potentials of floating grids, insulation leakage currents, capacitor dielectric leakages; and to study transistors and diodes. Its ruggedness, reliability, and high sensitivity make it especially suited for use in the nuclear field as a component in reactor control systems and in industrial control systems employing radioisotopes as energy sources. It can be used for pH determination, and in mass spectrometry. In biophysics and medicine it may be used to measure cell potentials, skin potentials, streaming potentials, injury potentials, and nerve impulses. Besides providing an indication on its own meter, it will operate any standard recorder. For details, write Nuclear Equipment Sales Dept., Curtiss-Wright Corporation, Electronics Division, Carlstadt, N. J.

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CORPORATION • CARLSTADT, N. J.

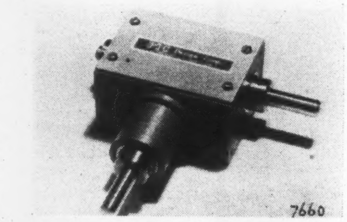
For more information circle **143** on inquiry card.

from stock in 48, 64, 72 and 96 pitch, 20° pressure angle; in stainless steel or 24ST Aluminum.—*PIC Design Corp., 160 Atlantic Ave., Lynbrook, L.I., N. Y.*

For more information circle **529** on inquiry card.

MITER GEAR BOXES

New "Type BA" precision miter gear boxes, available from stock, are of material certified under MIL applications. Available in 1/8″, 3/16″, and ¼″ shaft sizes.—*PIC Design Corp., 160 Atlantic Ave., Lynbrook, L. I., N. Y.*



For more information circle **530** on inquiry card.

PRECISION PYREX BALLS

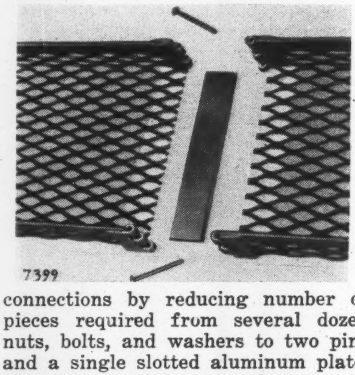
New precision-ground Pyrex glass balls, non-conductive and unaffected by heat and cold, offer a wide application in electronics and where corrosion resistance is required; are light in weight, shock-resistant and with high load capacity. Stock sizes from 1/16″ to 1″; special sizes to order. Accuracy better than 0.001″ on diameter and 0.0005″ on sphericity.—*Hartford Steel Ball Co., Inc., West Hartford, Conn.*

For more information circle **531** on inquiry card.

TUBING, FITTINGS, etc.

COUPLER FOR TUBE TROUGHS

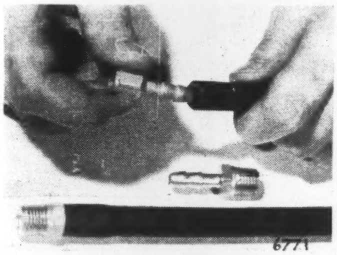
New "Pin-Type Coupler," connecting sections of "Instrof" used to support instrument tubing, simplifies connections by reducing number of pieces required from several dozen nuts, bolts, and washers to two pins and a single slotted aluminum plate. Plate overlaps bottom of two connecting pieces of "Instrof" and pins are driven into place through interlocking barrels on sides—*Instrof Corp., Div. of T. J. Cope, Inc., Collegeville, Pa.*



For more information circle **532** on inquiry card.

PUSH-ON FITTING

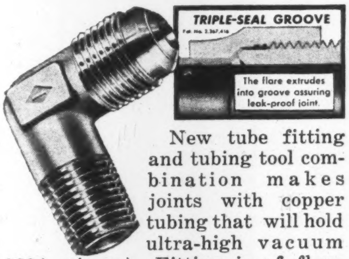
New push-on fitting features ease of installation. Low-pressure hose is pushed up over twin ferrules of fitting stem for a positive, tight fit.



Feature of new fitting is speed of hose replacement: fitting can be left on a machine and a new hose installed by maintenance personnel merely by pushing hose into place.—*Meridan Corp., Flex-O-Tube Div.,* 2525 *Jim Daly Rd., Inkster, Mich.*

For more information circle **533** on inquiry card.

HIGH VACUUM FITTING

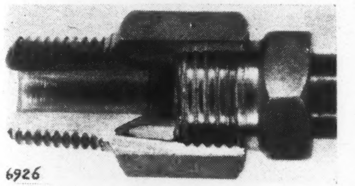


New tube fitting and tubing tool combination makes joints with copper tubing that will hold ultra-high vacuum (0.0004 micron). Fitting is of flare type with a groove in seat into which flare extrudes when joint is made.—*Imperial Brass Mfg. Co.,* 1200 *W. Harrison St., Chicago* 7, *Ill.*

For more information circle **534** on inquiry card.

SELF-FLARING FITTINGS

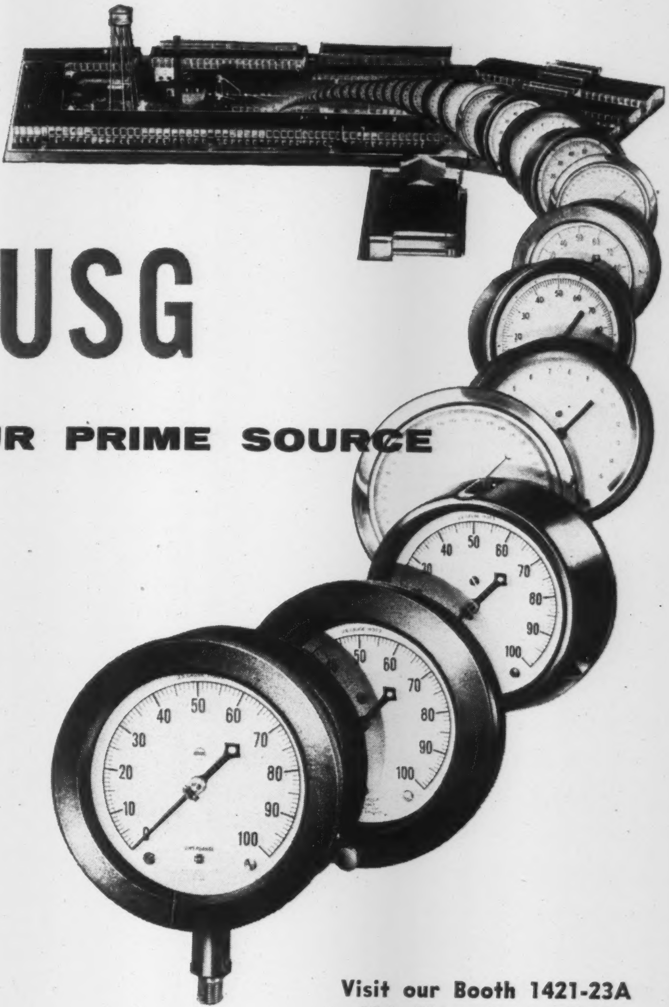
New "Flare-Matic" pressure-tight fittings minimize time and equipment required to connect standard tubing; are available as complete units, for tubing sizes from ¼" to ⅝" OD, in eleven designs including male, female, tees, tee-unions, etc.—*Century Controls Corp., Allen Blvd., Farmingdale, L. I., N. Y.*



For more information circle **535** on inquiry card.

TEFLON-SEALED COUPLING

New "HK" quick connect-disconnect coupling is for acids, alkali, solvents, high-pressure steam, "for previously impossible fluid transfer," is said to be "the first successful field-tested quick-connect coupling using



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Why "CHOKE" your soldering iron?

— just "CRADLE" it with a

HEXACON

HATCHET SOLDERING IRON

The operator has to "choke" the conventional straight iron to hold it, whereas the HEXACON HATCHET IRON "cradles" in the hand with no perceptible grip whatsoever — *thus relieving hand strain* and eliminating the "heavy hand", the cause of poorly soldered joints. Because HEXACON HATCHET IRONS are *perfectly balanced* in weight, they enable the operator to solder in a natural position and relieve fatigue of arm and back.

Send for new circular No. 70H giving more details and comparative competitive performance data.

A COMPLETE LINE
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25H	25	1/8"	$ 6.50
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70H	80	3/8"	11.00
100H	100	3/8"	12.00
150H	150	3/8"	12.75
151H	175	1/2"	13.50
200H	200	5/8"	14.00
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HEXACON ELECTRIC COMPANY
506 West Clay Ave., Roselle Park, New Jersey

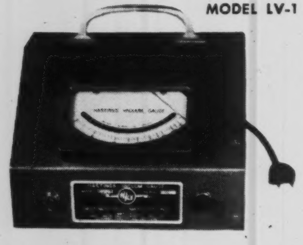
INDUSTRY'S No 1
HEXACON
TRADE MARK
SOLDERING IRON

For more information circle **145** on inquiry card.

HASTINGS VACUUM GAUGES

SET NEW STANDARDS OF ACCURACY, STABILITY, RESPONSE

MODEL LV-1

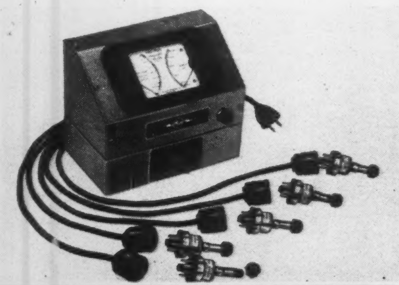


- **Easy To Read Scales**
- **Unusually Long Life**
- **Matched Gauge Tubes**
- **No Outgassing Or System Contamination**

NEW MODEL LV-1. Measures 0-100 micron Hg. Single meter; large 4" scale indicates vacuum directly without adjustments. Internal voltage regulator takes care of fluctuations in line voltage. Ideal for Industrial Installations. Also available in 0-1000 micron and 0 1-20 mm Hg. ranges.

MODEL GV-3 VACUUM GAUGE

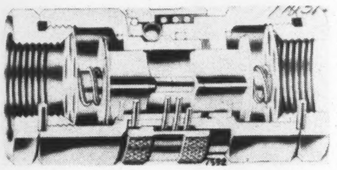
(Shown at right with optional 5-position switching attachment) Range from 0-1000 microns Hg. Manual current set and additional milliampere scale allow adjustment for use in presence of gases other than air, for leak detection, and for specialized laboratory use.



Evaluation by Users
PROVES SUPERIORITY
of Hastings Gauges
WRITE:

HASTINGS-RAYDIST INCORPORATED
HAMPTON 13, VIRGINIA
PHONE 3-6531

For more information circle **146** on inquiry card.

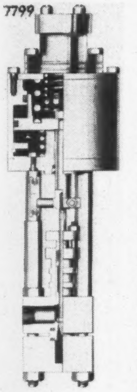


Teflon seals throughout." It will function perfectly between −100°F and 500°F and can be subjected to lower and higher temperatures for short periods.—*Snap-Tite, Inc., Union City, Pa.*

For more information circle **536** on inquiry card.

VALVES, etc.

SMALL-FLOW CONTROL VALVE

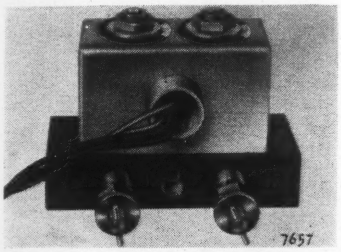


New "Model 9460" valve, for working pressures to 6,000 psi in research and pilot plant work as well as in industry, is extremely high-speed and responsive. It uses maker's "600 Series Domotor" operator with differential area piston which obviates need for loading regulator and strokes fully in either direction in 0.75 sec or less. Offset globe or angle bodies, with body sections rotatable in 90° increments for piping convenience. Also available: open-on-air-failure or close-on-air-failure action plus interchangeable valve trim in C_v 0.005 to 2.5.—*The Annin Company, 6570 E. Telegraph Rd., Los Angeles 22, Calif.*

For more information circle **537** on inquiry card.

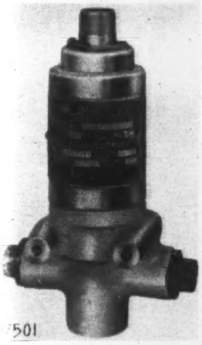
SOLENOID CONTROL VALVE

New single or double solenoid operating type is added to "BV Series" ¼"-port size air or hydraulic control valves; is available in both 3-way (3-port) and 4-way (5-port) types, for all voltages. All seals are standard O rings, replaceable without disturbing piping. Non-corrosive aluminum and brass are used throughout. Available with exhaust speed control valves (as shown), or open 1/4" NPT female ports.—*Modernair Corp., 400 Preda St., San Leandro, Calif.*



For more information circle **538** on inquiry card.

TWO-WAY SOLENOID VALVES



501

New two-way solenoid-operated shut-off valves for 3000-psi service provide extremely low leakage in closed position; exceed MIL-V-5529A. Other features: light weight, low pressure drop, and straight-through port construction which permits ompact straight-line runs of hydrau-ic tubing. Available in N-O or N-C ypes, for ¼", ⅜" or ½" hydraulic ube systems.—*Aircraft Products Co.*, 300 *Church Rd., Bridgeport, Pa.*

For more information circle **539** on inquiry card.

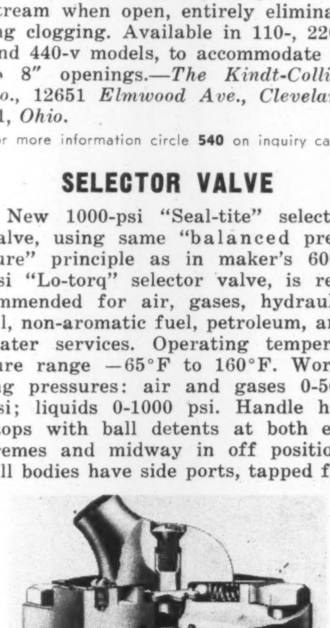
AIR CONTROL VALVE

New improved model of "Ventonatic Air Control Valve" for increasing efficiency of air suction systems and dust collectors is said to be ideal for use on woodworking and metal grinding and polishing machines, etc., producing dust, shavings, or lint. Valve operates automatically, concentrating suction of collector only at machines in operation, thereby improving efficiency. It presents an absolutely unobstructed passage for air stream when open, entirely eliminating clogging. Available in 110-, 220-, and 440-v models, to accommodate 3" to 8" openings.—*The Kindt-Collins Co.*, 12651 *Elmwood Ave., Cleveland* 11, *Ohio.*

For more information circle **540** on inquiry card.

SELECTOR VALVE

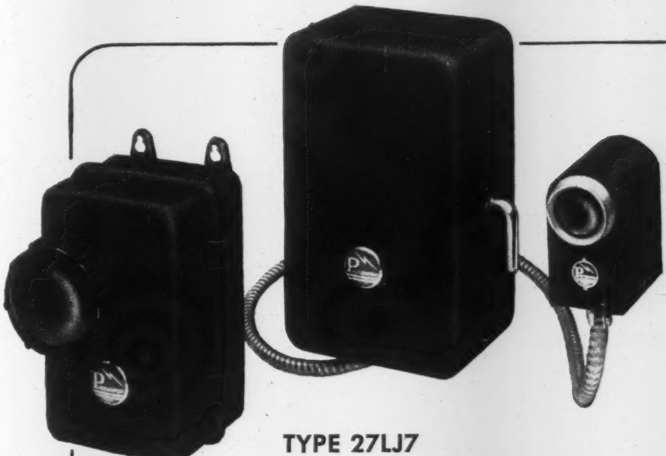
New 1000-psi "Seal-tite" selector valve, using same "balanced pressure" principle as in maker's 6000 psi "Lo-torq" selector valve, is recommended for air, gases, hydraulic oil, non-aromatic fuel, petroleum, and water services. Operating temperature range −65°F to 160°F. Working pressures: air and gases 0-500 psi; liquids 0-1000 psi. Handle has stops with ball detents at both extremes and midway in off position. All bodies have side ports, tapped for



7459

NEW **HIGH SENSITIVITY**

PHOTOELECTRIC CONTROL



TYPE 27LJ7

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Long Range Detection
Density Control
Turbidity Control
Surface Comparison
Flaw Detection
Registration Control
and many other operations

HERE IS THE UNMATCHED ANSWER for those applications where fast positive control must be based on small changes in light intensity.

SENSITIVITY of this new instrument is so high that its relay will operate on a received-light intensity of 0.05 foot-candle . . . about the amount of light received from a candle at 20 feet.

OPERATING DIFFERENTIAL is 0.02 foot-candle . . . with constant-voltage light source supply the control will detect the presence or absence of clear water in an ordinary tumbler through which the light beam passes.

RELIABILITY rests on the use of top-quality components, operated well below their ratings, and engineered into a circuit incorporating the latest techniques of electronic design.

Standard models available with meters and recorders — scanner available with adjustable iris diaphragm which provides precise control of the amount of received light. Extended lens system for light source and receiver can be supplied for operation over long distances. For full details write for Bulletin PA 561.

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For more information circle **147** on inquiry card.

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Specialists in the Unusual

More and more people are turning to us for electroplated wire. We electroplate by continuous methods a wide variety of wire in a range of diameters from .035" to the smallest available. In our laboratory, Tungsten wire as small as .00015" has been electroplated with Gold . . . New applications for electroplated wires on different base materials are being developed from time to time . . .

Your inquiry is invited. Consult our staff, without obligation, about your specific wire problems.

SIGMUND COHN MFG. CO., INC.
121 SOUTH COLUMBUS AVENUE, MOUNT VERNON, N. Y.

WRITE FOR LIST OF PRODUCTS

For more information circle **148** on inquiry card.

INSTROF

Continuous Support and Protection for Instrument Tubing

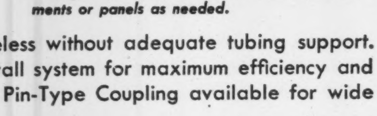
Tubing may readily be run to individual instruments or panels as needed.

Delicate instruments quickly become useless without adequate tubing support. Instrof provides a flexible, simple-to-install system for maximum efficiency and dependability at minimum cost. Famous Pin-Type Coupling available for wide range of standard fittings and runs.

Instrof is a system of Prefabricated Expanded Metal Trough specifically designed for rigid, continuous support and protection of instrument tubing. All parts are hot-dip galvanized for long life. Widths of 3", 6", 9", 12", 18", and 24", lengths of 8', 10', and 12', and a complete line of fittings allow the Instrof system to meet the demands of virtually any plant layout.

Exclusive Pin-Type Coupling speeds installation and reduces labor costs. Just two coupler pins and a bottom plate are needed to complete a connection.

INSTROF CORP.
DIVISION T. J. COPE, INC.
COLLEGEVILLE 21, PENNA.



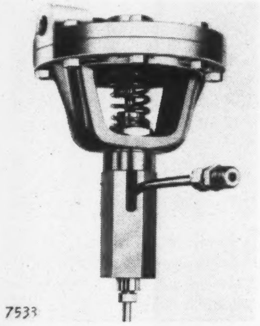
For more information circle **149** on inquiry card.

4-way closed center service. To obtain 2-way or 3-way service, insert standard pipe plugs in ports not to be used. Unit is designed for panel mounting, ⅛" maximum thickness. Sizes ⅛" to 1".—*Republic Mfg. Co., 15655 Brookpark Road, Cleveland 11, Ohio.*

For more information circle **541** on inquiry card

"SPHINCTER VALVE"

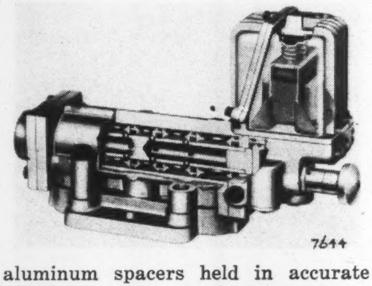
New "Sphincter Valve" is designed for handling erosive process flows or flows containing gritty solids which cannot tolerate pockets but accept neoprene or natural rubber. It produces minimal turbulence. It is suitable for use on slurries that tend to plug conventional type control valve. Only parts exposed to wear are a rubber seat and an "O" ring. Seat is compressed along its axis to produce throttling action and tight closure. Available in ⅜" and ¼" OD tubing sizes. Manual or air operators are available for quick interchange.—*George W. Dahl Co., Inc., 430 High St., Bristol, R. I.*



For more information circle **542** on inquiry card.

CONTROL VALVES

New "B-Type" valves, said to offer many new features never before available, have valve chambers formed by aluminum spacers held in accurate metal-to-metal end abutment, permitting quick easy servicing in the field if necessary. Solenoid-operated valves (all of pilot-operated design) are conservatively rated at 600 cycles per minute for continuous operation on air at pressures from 40 to 150 psi (much higher speeds for intermittent duty on air at 80 to 100 psi). Exterior feed type valves can be used in hydraulic service at pressures up to

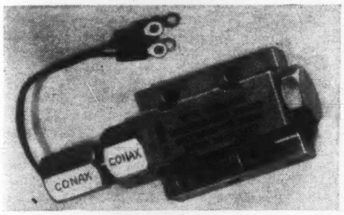


250 psi using air for pilot medium. Interior feed type valve can be used on oil from 40 to 150 psi at somewhat lower cycling speeds.—*C. B. Hunt & Son, Salem, Ohio.*

For more information circle **543** on inquiry card.

EXPLOSIVE VALVE

New "Standard Model Explosive Valve" is a dead-tight shut-off valve for long- or short-time storage of gas



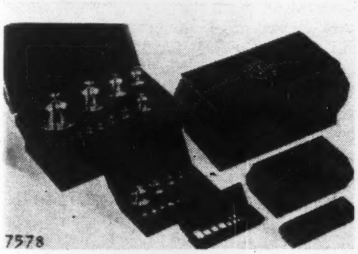
r liquid under high pressure; operates instantaneously by firing a small completely contained explosive squib. Maximum operating pressure 5,000 psi; proof pressure 10,000 psi; sealed against back pressure up to 4,500 psi. on downstream side permitting proof testing of system before firing.—*Conax Corp.,* 7811 *Sheridan Drive, Buffalo* 21, *N. Y.*

For more information circle **544** on inquiry card.

LABORATORY EQUIPMENT

WEIGHT SETS

New sets of weights are contained in "Sto-A-Weigh" hinged-covered boxes, thus assuring retention of ac-

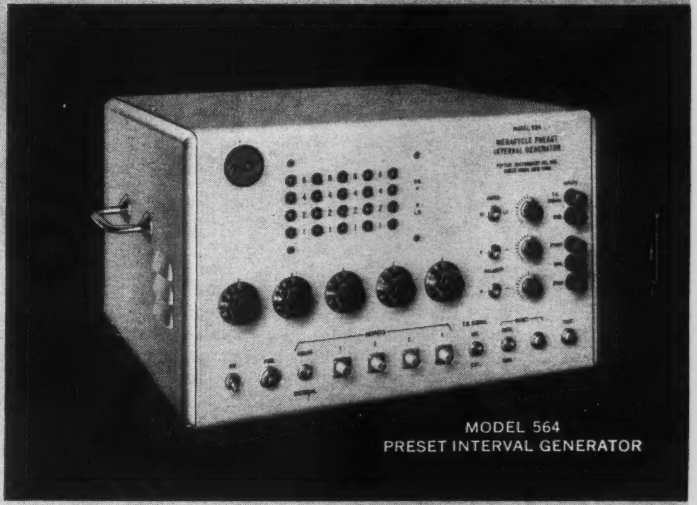


curacy for a long time. Weights are designed to comply with new NBS specs for classes Q and P and conventional class C. Each set comes with a pair of stainless-steel forceps.—*Ohaus Scale Corp.,* 1050 *Commerce Ave., Union, N. J.*

For more information circle **545** on inquiry card.

LABORATORY OSCILLOSCOPE

New "Mark IA" features a versatile dual-band-width direct-coupled amplifier, and a precision calibrated time base. In wide-band position, vertical sensitivity is 1 volt per inch; in narrow-band position it is increased by a factor of four; wide-band capacitively coupled preamplifier further increases amplifier sensitivity to 25 mv./in peak-to-peak. A 0.15-usec distrib-


MODEL 564
PRESET INTERVAL GENERATOR

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GENERATOR

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SINGLE RANGE 100,000 STEPS

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GENERATE VOLTAGE GATES
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- Accepts any external time base up to 1 megacycle
- Fast reset—recycles in 50 microseconds
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For more information circle 150 on inquiry card.

EXTENDED *FREQUENCY RANGE*

with these STANDARD SIGNAL GENERATORS

MODEL 80
2 Mc to 400 Mc

MODEL 80-R
5 Mc to 475 Mc

FEATURES

- Direct-Reading scales and dials; individually calibrated.
- Convenient microvolt and DBM output scales.
- Accurate indication of output voltages at all levels.
- Low residual FM due to hum and noise.
- Provision for external pulse modulation.

SPECIFICATIONS

FREQUENCY RANGE: (Model 80) 2 to 400 Mc in 6 bands.
(Model 80-R) 5 to 475 Mc in 6 bands.
FREQUENCY ACCURACY: ± 0.5%
FREQUENCY DRIFT: Less than .1% after warm-up.
OUTPUT VOLTAGE: Continuously variable from 0.1 to 100,000 microvolts (−7 to −127 DBM).
OUTPUT ACCURACY: ±10% at 0.1 volt from 5 to 200 Mc.
±15% at 0.1 volt from 200 to 475 Mc.
MODULATION: AM is continuously variable from 0 to 30%.
Internal modulation, 400 and 1000 cycles.
External modulation, 50 to 10,000 cycles.
RESIDUAL FM: Less than 500 cps at 450 Mc for Model 80-R, and correspondingly lower for both models at lower frequencies.
POWER SUPPLY: 117v, 50-60 cycles, 70 watts.

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For more information circle **151** on inquiry card.

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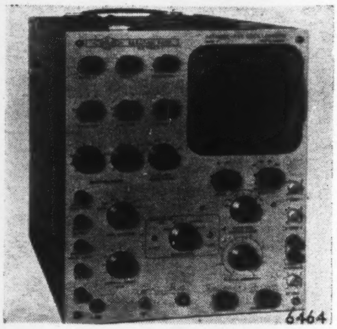
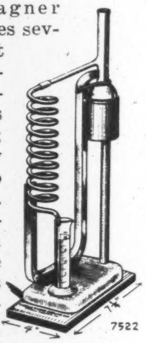


6464

uted parameter delay line can be inserted or removed by a front-panel switch. Precision attenuator permits direct-reading voltage measurements from 25 mv/in to 100 v/in peak-to-peak. Time base range 10,000 usec/in to 0.25 usec/in; internal timing markers; accuracy better than 2%.—*Republic Electronic Industries Corp.*, 31 *W. 27th St., New York* 1, *N. Y.*

For more information circle **546** on inquiry card.

DISTILLING UNIT



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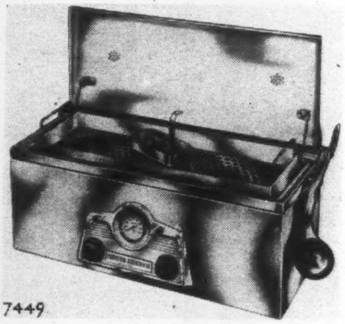
New "Cargille-Wagner Distilling Unit" provides several new features that facilitate small distillations; requires no tripod, ring stand, clamps or water connections; is easily set up, easily operated; needs only to be plugged into line. Six units can be operated at one time on 36"-wide lab table space. Portable case is optional.—*Cargille Scientific Inc.*, 117 *Liberty St., New York* 6, *N. Y.*

For more information circle **547** on inquiry card.

STERILIZER

New "Multimode" single-unit sterilizer for sterilization by dry heat,

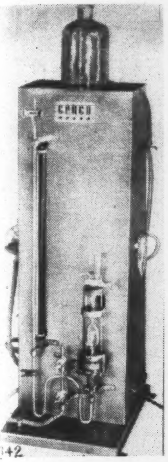


7449

boiling, oil or chemical action, offers all advantages of dry-heat sterilization, yet can be changed readily to other methods; has a finger-tip dual thermostat system with a sensitivity of 1 C°.—*Precision Scientific Co.*, 3737 *West Cortland St., Chicago* 47, *Ill.*

For more information circle **548** on inquiry card.

VAN SLYKE APPARATUS

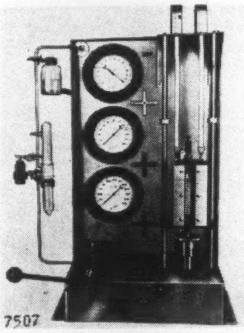

7342

Newly improved Van Slyke Apparatus for blood gas analyses retains original principles and measuring techniques of Van Slyke design, but improved mechanical construction enables it to operate with less vibration than former models; also features finer lighting for easier measurements. Convenient, precise readings of etched "Blue Line" graduations on mercury column are facilitated by a 24" fluorescent tube which provides an illuminated white background for column.—*Central Scientific Co., 1700 Irving Park Road, Chicago, Ill.*

For more information circle **549** on inquiry card.

POROSIMETER

New "Aminco-Winslow Porosimeter" performs a complete pore-structure analysis of any porous material in a ten-minute operating cycle; measures sizes of pores ranging from 0.1 mm to 0.06 microns, and pore volumes as small as 0.0005 ml at each pore diameter. It operates on mercury-intrusion principle, is completely hydraulic (gas-free), and devoid of operational hazards.—*American Instrument Co., Inc., Silver Spring, Maryland.*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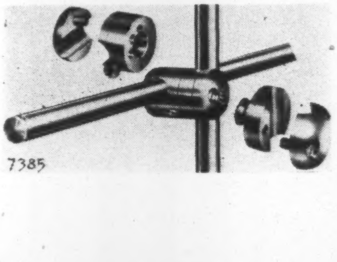
For more information circle **550** on inquiry card.

APPARATUS CLAMP

New "Universal Clamp" provides complete versatility for secure mounting of set-ups and pilot apparatus;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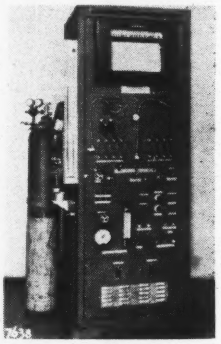
For more information circle **153** on inquiry card.

permits multiple rod attachment at any two-dimensional angles; a swivel attachment provides any three-dimensional angles. There is also a special attachment for wall and floor mounting and couplings.—*The Emil Greiner Co.*, 20-26 *N. Moore St., New York* 13, *N. Y.*

For more information circle **551** on inquiry card.

CHROMATOGRAPH

New "Hallikainen-Shell Chromagraph" features great versatility; suitable for analysis of gases, liquefied gases and liquids by adsorption as well as by gas-liquid partition techniques or combination thereof. Among other features: Wide temperature range (0 to 275°C); high-sensitivity high-speed recorder; continuous integration; plug-in column panels (two with each unit as standard); vacuum pump; sample mixing pump; precise flow control.—*Hallikainen Instruments*, 1341 *Seventh St., Berkeley* 10, *Calif.*



For more information circle **552** on inquiry card.

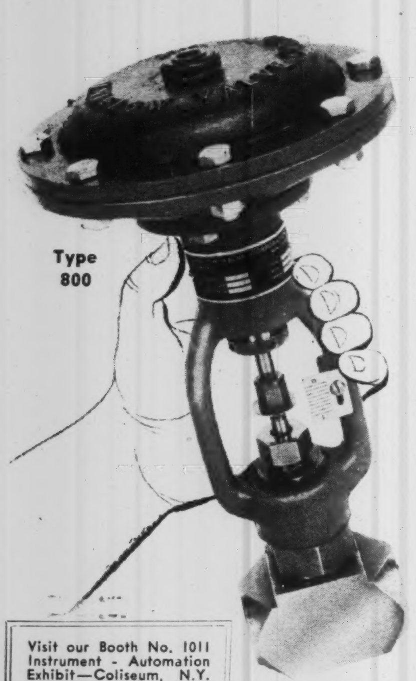
AUTOMATIC PIPETTE RINSER

New "Model B," made completely from polyethylene, features two improvements: (1) syphon tube redesigned so that rinser will empty in about 20 sec depending on rate of inflow; (2) special recess has been built into it so that rinse water is almost completely removed before refilling cycle begins. Two additional larger sizes are available for burettes and pipettes up to 33" long.—*The Nalge Co., Inc., P. O. Box* 365, *Rochester* 2, *N. Y.*

For more information circle **553** on inquiry card.

MERCURY SWITCH PULSER

New "N-101 Mercury Switch Pulser," for calibration and stability measurements involving scintillation



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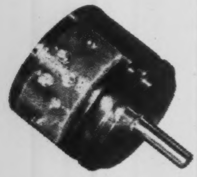
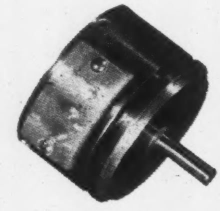


TYPE 751

Fairchild miniature precision potentiometers meet applicable portions of MIL-E-5272A for humidity, vibration, temperature cycling, fungus resistance and salt spray. These units, in ⅞" and 1⅛" diameters, are miniaturized without sacrificing performance. They meet the same requirements for accuracy and reliability as most standard precision units up to 2" in diameter.

MINIATURE SINGLE TURN POTENTIOMETERS linear and nonlinear

Precision in linear and nonlinear functions is assured with each of these Fairchild miniature potentiometers — available with card or mandrel windings. 0.5% standard accuracy, 0.25% special accuracy available. Terminals gold-plated for reduced contact resistance and easier soldering. Type 751 (⅞" dia.—weight 13 grams) has a resistance range up to 75K ohms, standard and 125K ohms, special. Type 741 (1⅛" dia.—weight 20 grams) has a resistance range up to 100K ohms, standard and 200K ohms, special. Special clamp permits ganging up to five units without increasing the overall diameter.



TYPE 741

SAMPLES AVAILABLE ON ORDER
Fairchild's complete line can help solve all your precision potentiometer problems. For more information write Fairchild Controls Corp., Components Division, 225 Park Avenue, Hicksville, L. I., N. Y.; (WEST COAST: 6111 E. Washington Blvd., Los Angeles, Calif.,) Dept. 140-73BI.

FAIRCHILD
PRECISION POTENTIOMETERS and COMPONENTS

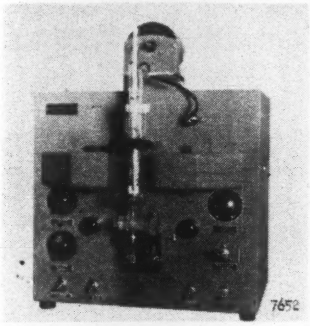
For more information circle **155** on inquiry card.

spectrometry circuits, features continuously adjustable rise time (0.03-0.5 sec); output up to 10 ma (max. 22 volts) either polarity and continuously variable with better than 0.1% linearity; battery pulse source; stability better than 0.1% per day after initial warm-up.—*Hamner Electronics Co., Inc., P. O. Box 531, Princeton, N. J.*

For more information circle **554** on inquiry card.

AUTOMATIC ANILINE APPARATUS

New Automatic Aniline Apparatus eliminates tedious and repetitious way of arriving at aniline, or mixed ani-

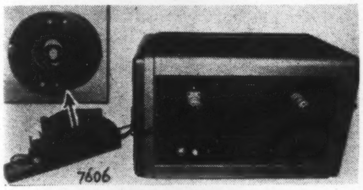


line point of a sample. Aniline points as low as 21°F, and as high as 220°F, can be easily taken. As many as 80 determinations can be taken in one workday.—*Koehler Instruments Co., Inc., 168-56 Douglas Ave., Jamaica 33, N. Y.*

For more information circle **555** on inquiry card.

LIGHT MODULATORS

New models of high-speed light pulsing and modulating equipment provide light pulses in microsecond



range and modulated light beams at variable frequencies from dc through video region. Light modulator is a crystalline analog of a Kerr cell. Five models of modulator meet a wide range of operating requirements. "Model JV-2" provides highest degree of versatility, features a moderately large angular field, has low voltage requirements and is designed for use at frequencies from dc to 10 Mc. Modulators of special crystal or case dimensions can be supplied on order. Two models of high-speed pulsers: "Type JK" produces pulses having a rise and decay time of about 0.2 usec and continuously variable widths from 50 to 1000 usec; "Type JS" produces pulses with rise and decay time of about 0.1 usec and a length of 2 usec. Pulse amplitudes are continuously

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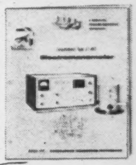

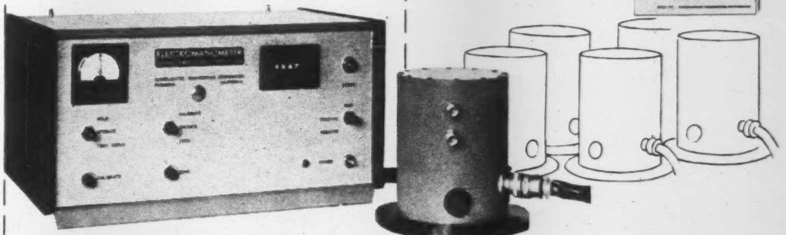

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MODEL TP-625

EXCLUSIVE FEATURES

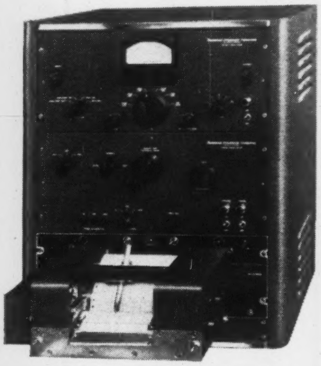
FREQUENCY RANGE	Complex waves consisting of individual components ranging in frequency from 2 to 25,000 cps can be analyzed.
BANDWIDTH	As narrow as 2 cycles, as wide as 200 cycles.
REJECTION SELECTIVITY	Minimum of 300:1 (50 db)
SELECTIVITY	Constant frequency bandwidth with selectivity as great as 10 db per cycle anywhere within the band.
FREQUENCY RESPONSE	±1 db from 5 cps to 15,000 cps; ±2 db from 2 cps to 25,000 cps.
SIGNAL TO NOISE RATIO	At least 55 db below full output level.

Technical Products Company's new TP-625 Frequency Analyzer offers performance features available for the first time in complex wave analysis.

Unselective analyzers, providing the average of a broadband spectrum, are now outmoded by the TP-625, the first instrument to "pull-out" and measure those close-together, hard-to-analyze, frequency components.

Now by using a TP-4A Level Recorder with the new TP-625 you can record your results up to 50 db without changing scales and in perfect synchronism with the Analyzer. The two instruments provide a permanent detailed analysis of any acoustic, vibratory or electrical wave source within their frequency range. Write for further details.

See our Analyzers at the New York City I.S.A. Show in September, Booth 120



TP-625 Frequency Analyzer Rack-mounted with a TP-4A Level Recorder

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For more information circle **157** on inquiry card.

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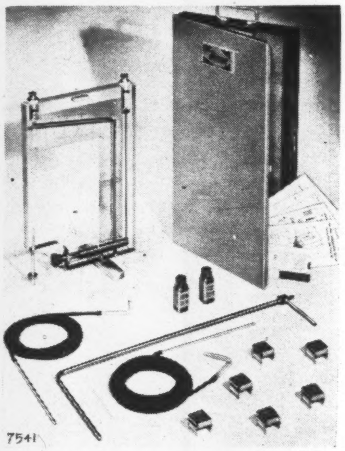
variable from 2 to 5 kv. Special models with different pulse widths or repetition rates can be built on request. For signals of arbitrary shape, special modulating amplifiers can be supplied for audio or video bandwidths. Tuned amplifiers requiring little power are adequate for fixed or variable single sine-wave light-intensity modulation.—*Baird Associates-Atomic Instrument Co., 33 University Road, Cambridge 38, Mass.*

For more information circle **556** on inquiry card

MISCELLANEOUS

DUAL-PURPOSE GAGE

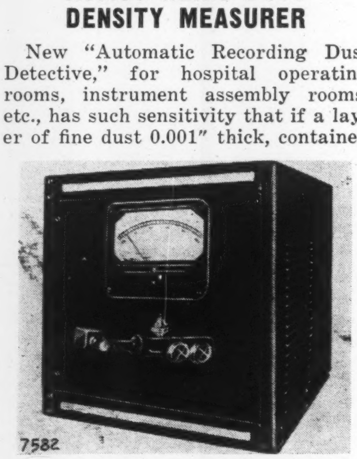
New "No. 400" measures both air velocity in feet per minute and static pressure in inches of water; reads directly (no reference to graphs or tables); is available in two capacities: "Model 400-5," 0-5" water, 400-9,000 fpm; "Model 400-10," 0-10" water, 400-12,600 fpm.—*Dep't IAP, F. W. Dwyer Mfg. Co., P. O. Box 373, Michigan City, Indiana.*



For more information circle **557** on inquiry card.

ATMOSPHERIC DUST DENSITY MEASURER

New "Automatic Recording Dust Detective," for hospital operating rooms, instrument assembly rooms, etc., has such sensitivity that if a layer of fine dust 0.001" thick, contained

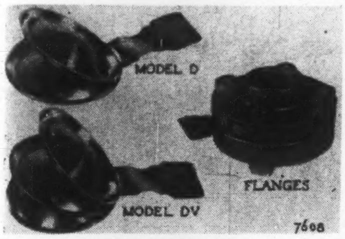


on ¼" dia head of a nail, is uniformly dispersed in a dust-free room 8x10x15 feet, it responds immediately with a deflection of 20% of full scale. It can also measure heavy dust loads that would approximate a fog reducing visibility to 30 ft. This large range is obtained on a single scale (without making sensitivity adjustments) through logarithmic amplification.—*Phoenix Precision Instrument Co.,* 803-05 *N. 5th Street, Phila.* 40, *Pa.*

For more information circle **558** on inquiry card.

RUPTURE DISCS

New type of rupture disc extends advantage of safety head protection to many installations now operating under pressure, temperature and corrosive conditions too severe for conventional type discs; also makes lower minimum rupture pressures possible and gives extended service under pressure surges that approximate rupture pressure.—*Black, Sivalls & Bryson, Inc.,* 7500 *E.* 12*th Street, Kansas City* 26, *Mo.*



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HIGHWAY SIGNAL

New "Wig-Wag Highway Flasher," said to represent "a completely new concept in highway warning devices," has alternately flashing lights as used at railroad crossings (far greater attention value than even the brightest single light). It provides greater protection at "about half the cost of the high-intensity signal." Available for battery operation, for 110-v ac or dc power line or generator. New plastic lenses intensify brilliance of battery-operated units.—*Davis Emergency Equipment Co., Newark, N. J.*

For more information circle **560** on inquiry card.

PAPER SAMPLER

New "Sample Pro-Tak-Tor," comprised of two metal platens joined by a spring hinge, is inserted under outer plies of rolls or skids and is clamped about inner plies. Samples,

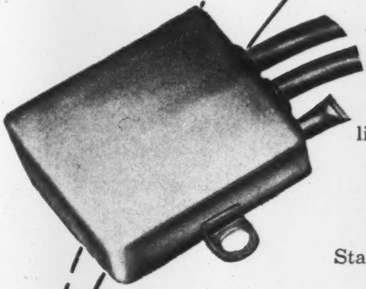
Another New
CPI thermal switch
It's the versatile **FLAT-STAT**

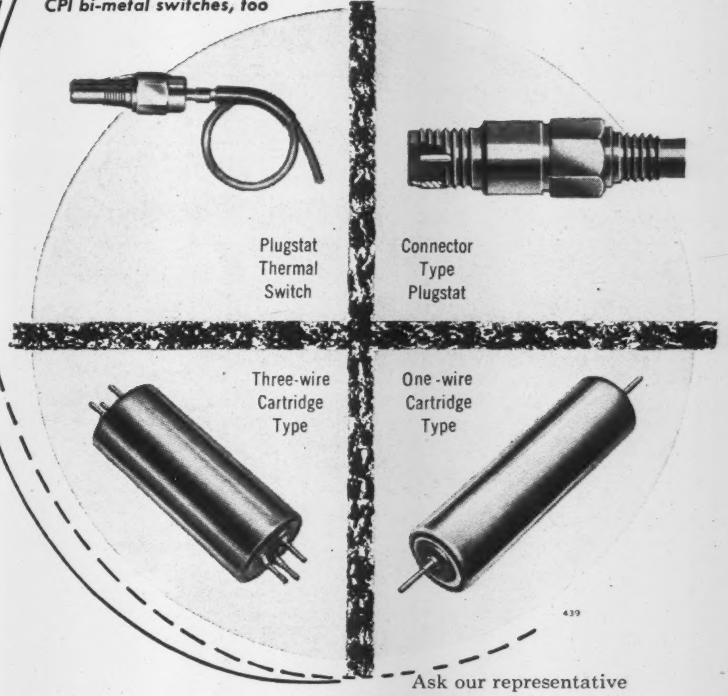
This new, highly sensitive, light weight, (weighs slightly more than ½ ounce) flat thermostatic switch is adaptable to signal unsafe surface or internal temperature of transformers, relays etc. as well as to control air conditioners in planes, and on motors and heaters. Because it is hermetically sealed, this new Flat-Stat can be immersed in non-conductive liquids to control temperatures in baths.

The Flat-Stat is available in 2 Amp. and 6 Amp. models. Calibration temperature range is −20°F to +650°F with momentary overshoot to 800°F. Standard tolerance is ±10°F but can be set to ±5°F if necessary. Repeatability is approximately ±1°F.

Wherever the need calls for a small, extremely accurate switch, investigate this new CPI Flat-Stat.

Ask about these CPI bi-metal switches, too

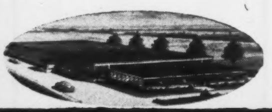




Ask our representative to tell you how CPI can help you solve your temperature control problem—and remember—when temperatures are high (or low) you can depend on CPI
Write for complete engineering data.
Ask for catalog IA

Control products, inc.
HARRISON, N. J.

For more information circle **159** on inquiry card.



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shielded from the atmosphere, are then taken by cutting or tearing around "Sample Pro-Tak-Tor" and are then slipped into moisture- vapor-resistant "special Sample Pro-Tak-Tor Pouch." When correctly used, new device takes and protects sample before it is exposed to atmospheric humidity. Pouch protects samples from moisture change until they are used. Some tests are even performed while samples remain within pouch. *—Paper Industry Instruments, Inc., 3398 Ingleside Rd., Cleveland 22, Ohio.*

For more information circle **561** on inquiry card.

WIDE-ANGLE LENS

New 28mm f/3.5 "Angenieux" wide-angle lens with pre-set diaphragm is for "Alpa" (Swiss-made) 35-mm single-lens reflex camera. This extreme-coverage (75°) retrofocus lens has a pre-set mechanism said to be "simplicity itself."*—Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.*

For more information circle **562** on inquiry card.

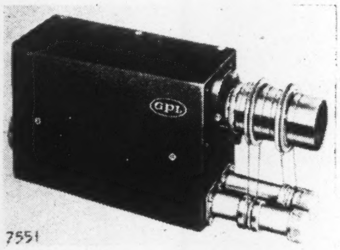
INDUSTRIAL TV CAMERA

New "Model 320-A Studio Camera," said to be built to work long hours without maintenance, features a four-unit hinge-mounted chassis and plug-in hinge-secured amplifier strips, providing easy accessibility to all components without need for tools. Provision is made for four lenses which can be quickly interchanged from operator's position. Optical focusing is unusually smooth. Camera can be used with or without the view-finder, is adaptable to film use, is suited for critical closed-circuit TV.*—Dept. MJ, Dage Television Div., Thompson Products, Inc., Michigan City, Ind.*

For more information circle **563** on inquiry card.

RUGGEDIZED TV CAMERA

New "Model PD-152" has been designed for operation in high vibration, noise and environmental conditions encountered in flight testing, engine test stand, automotive, research, manufacturing and military applications. It weighs 6 lbs; is the only camera which has operated successfully under flight conditions with forces exceeding 15 G in each of its three axes.*—General Precision Lab., Inc., Pleasantville, N. Y.*



For more information circle **564** on inquiry card.

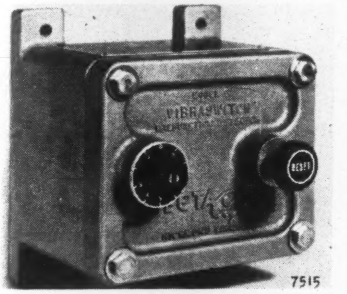
2-PIN-STYLE LAMPHOLDERS AND INDICATING LIGHTS

New specially-designed lampholders and indicating light units accommodate new G-E 2-pin-base miniature lamps #10, #12 or #15; are supplied with wire leads or solder lugs, with or without jewel assembly, on a variety of mounting brackets. Indicating light unit features low cost and reduced height, whence space saving in many applications.—*Drake Mfg. Co., 1711 W. Hubbard St., Chicago 22, Ill.*

For more information circle **565** on inquiry card.

VIBRATION-TYPE MECHANICAL MALFUNCTION DETECTOR

New "Model 5 Vibroswitch" anticipates and prevents trouble in rotating and reciprocating machines by responding to slight increases in roughness and causing a shutdown before failure occurs; includes shock-free holding and reset mechanism for automatic or remote operation to prevent actuation from starting or from normal or accidental transient shocks; employs no vacuum tubes or electronic components, is maintenance-free and fail-safe; is supplied in an explosion-proof housing.—*The Beta Corporation Forest Ave. at Ridge Rd., Richmond 26, Va.*

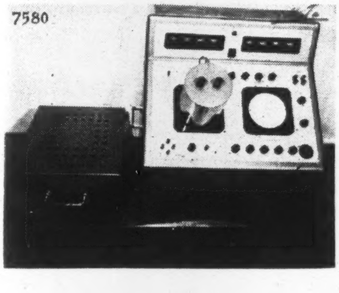


7515

For more information circle **566** on inquiry card.

DAMPING MEASURER

New "Dampometer" (Swedish-made) measures logarithmic decrement and frequency in structures, acoustics, metallurgy, aerodynamics, electronics, etc. Manufacturer states that in some instances it can pay for itself in three weeks through savings in man-hours and in use time of wind tunnels and similar installations. In operation, a damped sinoidal voltage is represented by a rotating vector on



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TURBINE FLOWMETERS

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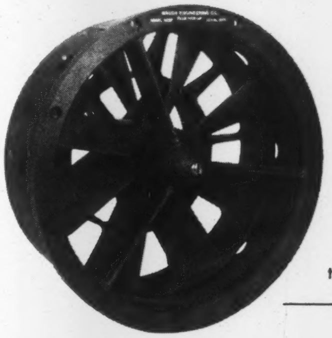
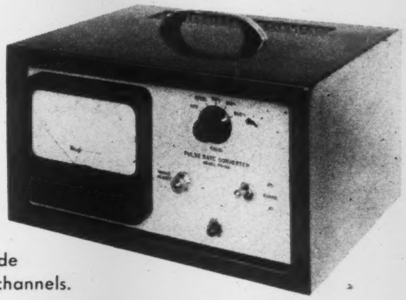


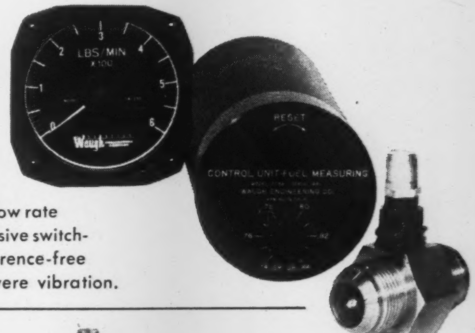
MISSILES

Lightweight aluminum Flow Pickups for flight or ground testing insert in propellant ducts of guided missiles. Flow rates from 20 to 6000 gallons per minute are covered in sizes 4" through 11". Output is suitable for telemetering or ground recording.



LABORATORY

FR series Pulse Rate Converters convert frequency output of any turbine flowmeter into a DC signal. Models include cabinet or relay rack mounting, with outputs for potentiometer recorders or oscillographs. Available features include built-in indicator, and multiple input channels.



AIRCRAFT

New, completely transistorized Airborne Fuel Measuring System with specific gravity adjustment provides direct indication of both fuel flow rate and total fuel consumed. Exclusive switch-type flow pickup gives interference-free operation in conditions of severe vibration.

GENERAL SERVICE

Standard FL series Flow Pickups for use in aircraft, chemical processing, food, and petroleum industries, measure flows from .065 to 400 gallons per minute. Applications include flow rate indication, recording, and control, as well as indication and control of totalized flow.

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For more information circle **162** on inquiry card.

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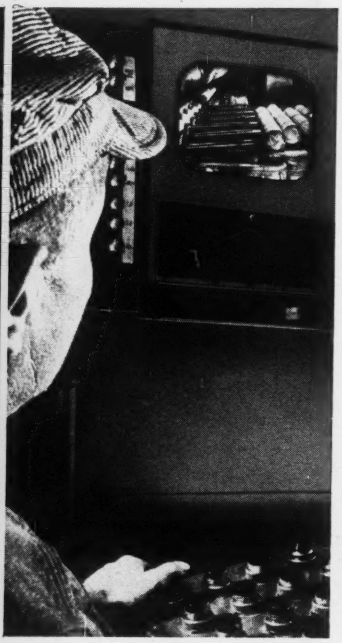
DIAMOND ITV UNITS
(WIRED TELEVISION)
AFTER 3 SUCCESSFUL INSTALLATIONS

Picture of furnace interior on Diamond ITV viewing screen is watched by remote dispatcher. A flip of a switch and he SEES conditions in another furnace on same screen.



Operator at another control pulpit SEES a visually inaccessible billet loading area for a pusher type furnace.

The Timken Roller Bearing Company made its first application of Diamond Industrial TV in August 1951 for remote observation of the interior of a tube-cooling furnace. Since that time two additional installations have been made to watch (1) the inside of another furnace and (2) the remote handling of billets by a crane. The success of these has resulted in a recent order for two more sets of Diamond ITV.

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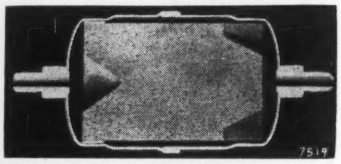
For more information circle 163 on inquiry card.

CRT screen. Rate of decrease in vector's length is an accurate measurement of damping. Results are shown simultaneously on two 4-digit electronic counters. Frequency range 0.5 to 500 cps; log decrement range 0-2.0. Instrument comes with power supply. —*Oltronix Co., 235 Underwood Drive, Atlanta 5, Ga.*

For more information circle **567** on inquiry car

INSTRUMENT AIR FILTERS AND DRIERS

New "High Efficiency Filter-Drier" is adsorbent and absorbent; utilizes a unique porous core molded of selecte

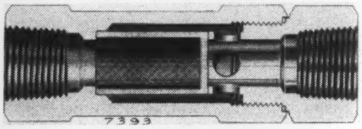


mesh size granules of activated alu mina. This desiccant cannot powder, cannot pass into system; cannot pack or channel; does not affect air or ga chemically. Six sizes.—*The Briggs Fil tration Co., River Rd., Washingto 16, D. C.*

For more information circle **568** on inquiry card

LINE FILTERS

New "Micron-Filter" brass an stainless steel line filters are to be used in conjunction with any valve

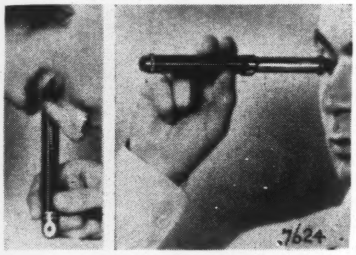


handling small flows if foreign dust or particles in fluid stream tend to clog throat, change effective opening, or obstruct full closing of valve. Replaceable bronze filter element is capable of filtering out particles larger than a 5 to 12 micron range. Available in ⅛" and ¼" female pipe sizes. —*Hoke, Inc., 231 So. Dean St., Englewood, N. J.*

For more information circle **569** on inquiry card

MICROSCOPE-TELESCOPE

New pocket instrument combines a 50-power microscope and a 10-power telescope. Metal reflector throws light on field of microscope. To use as a telescope, unscrew metal reflector.

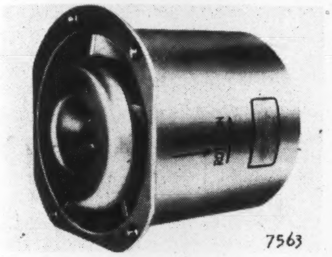


draw out eyepiece tube and sight.—*Edmund Scientific Corp., Barrington 13, N. J.*

For more information circle **570** on inquiry card.

FAN-BLOWER UNIT

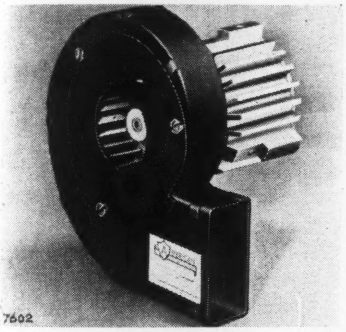
New "BC 2914 F-1" unit for airborne equipment compensates for low air density by increasing blower speeds. At sea level 8000 rpm, 210 cfm, 2" back pressure. At 60,000 feet, 11,000 rpm.—*Induction Motors Corp., 570 Main St., Westbury, Long Island, N. Y.*



For more information circle **571** on inquiry card.

CENTRIFUGAL BLOWER

New centrifugal blower is designed to cool electronic components where higher back pressures have become a problem. Typical air delivery is 60 cfm against 4" S.P. when driven by a motor at 11,000 rpm.—*American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.*



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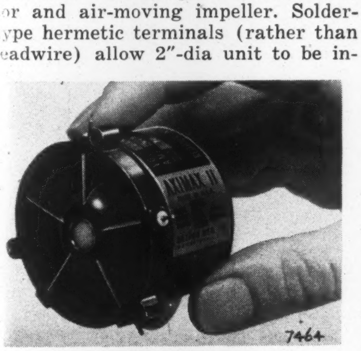
EQUIPMENT COOLING FAN

New "Aximax II" miniature cooling fan features vaneaxial design: novel in that motor is of inside-out construction with one-piece electrical rotor and air-moving impeller. Solder-type hermetic terminals (rather than leadwire) allow 2"-dia unit to be in-



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set-up and sharpen
small drills
in 30 seconds

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- No skill required
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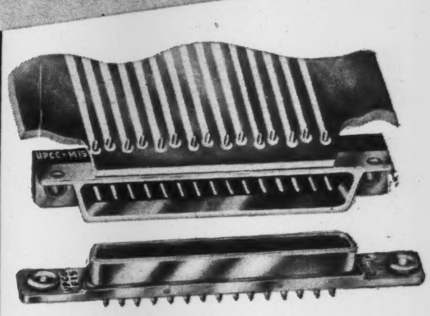
PRECISION CONNECTORS for PRINTED CIRCUITRY



U. S. Components' printed card connectors embody all the design features demanded by printed circuit users. Minimum space, high-compression molded inserts, die-cast aluminum shells result in polarization flexibility and high electrical and mechanical performance even under the most severe environmental conditions.

Series UPCC connectors are available with 7, 11, 15, 19 or 23 contacts for 1/16", ⅛" and ¼" printed cards.

Write TODAY for complete information on U.S.C. printed card connectors and receptacles and the name of nearest U.S.C. engineering representative.

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Lewis' name goes on the "P.O.'s" of so many large companies for one or maybe all of the reasons mentioned above. We're proud of that—and we are certainly going to make sure that all of our present and future spring buyers have the same important reasons to put "Lewis" on the order—and more too, if we can find them. How can we help you?

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Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material

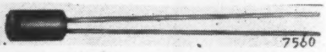
For more information circle **166** on inquiry card.

serted airtightly in a closed piping system.—*Rotron Mfg. Co., Schoonmaker Lane, Woodstock, N. Y.*

For more information circle **573** on inquiry card.

PHOTOCELLS

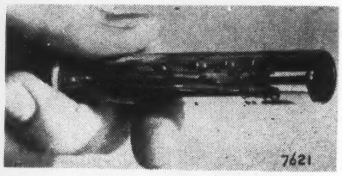
New "Powermaster" cadmium sulphide photocell is a highly miniaturized unit that can control a commercial sensitive relay without amplification at normal daylight level; is sensitive over entire visible spectrum with peak sensitivity at blue-green; ha low noise level and high dark resistance. Stability is rated excellent s long as power dissipation rating i not exceeded. Units are divided int eleven sensitivity categories: low-impedance cells are intended primaril for direct relay operation; high-impedance cells for use with an amplifier.—*Hupp Electronics Co., 743 Circl Ave., Forest Park, Illinois.*



For more information circle **574** on inquiry card.

MULTIPLIER PHOTOTUBE

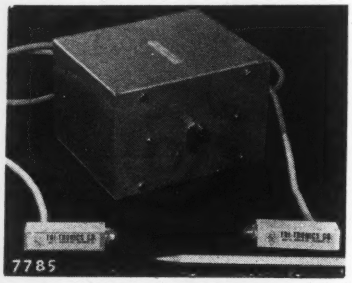
New "Type K 1382" ¾" ten-stag multiplier phototube has a rated average gain of 300,000 at 105 v per stage. At this potential, maximum dark current is 0.1 uamp, photo-cathode sensitivity is 40 uamp/lumen and averag anode sensitivity is 12 amp/lumen.—*Instrument Dep't, Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*



For more information circle **575** on inquiry card.

PHOTOELECTRIC CONTROL

New "Photo-electric Relay" features (1) unusually small light-source and photocell, (2) no tubes or transistors, (3) simple circuit insuring industrial reliability; operates o 110/220-v 60-cps. Output: counter o contact rated 2 amp, sp-dt, speeds t 60 cps.—*Tri-Tronics Co., 2607 St Charles Rd, Bellwood, Illinois.*



For more information circle **576** on inquiry card.

LETTERING TEMPLATE

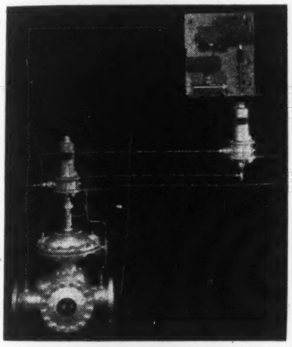
New "No. 925 Lettering Aid Template" for neatness in free-hand lettering, has slots for letter sizes ⅛",

5/32", 3/16" and ¼". Slots are beveled, and reversing template allows use with inking pen. There are also printed guide lines for equi-distant spacing. Size 6⅞" x 3⅜".—*Rapidesign, Inc., Box 592, Glendale, Calif.*

For more information circle **577** on inquiry card.

GAS-SYSTEM PROTECTOR

New "Telapilot" electrically-operated pilot regulator remote control system enhances safety and improved

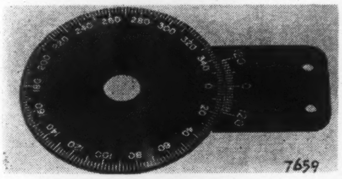


service for city gas distribution systems; is designed for use in intermediate and high pressure pilot-loaded distribution circuits; enables an operator at a central control station to raise or lower pressure setting on pressure regulators 10 to 15 miles away. By using a telemetering arrangement to spot pressure changes, he can rectify immediately any undesirable pressures at circuit outlets. —*Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.*

For more information circle **578** on inquiry card.

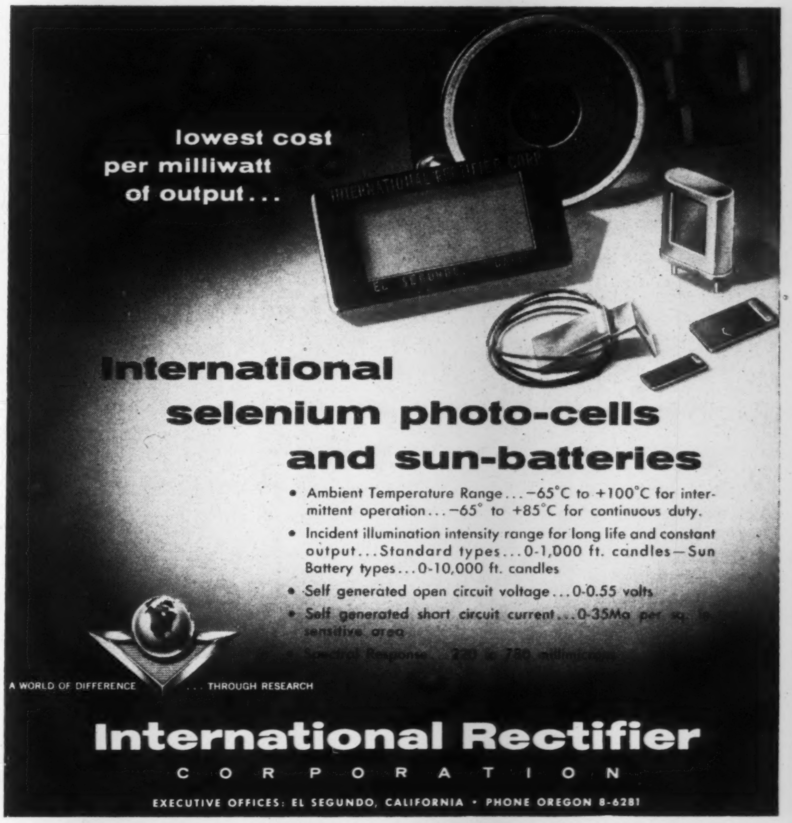
DIAL & VERNIER SET

New "Type AW" precision-engraved disc dial and vernier sets are immediately available from stock in



1½", 2", 3", & 4" diameters; can be read within 6 minutes of accuracy. —*PIC Design Corp., 160 Atlantic Ave, Lynbrook, L. I., N. Y.*

For more information circle **579** on inquiry card.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Range: —65° to + 350° F.
Heater: Electric strip heater
Coolant: Dry ice, 15 lbs. capacity
Control: Adjustable thermostat & selectable heat inputs
Load Capacity: 600 cubic inches of test materials
Power: 115V, 5 amp. 50-60 cycle
Overall Size: 48"x16½"x12"
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For more information circle **168** on inquiry card.

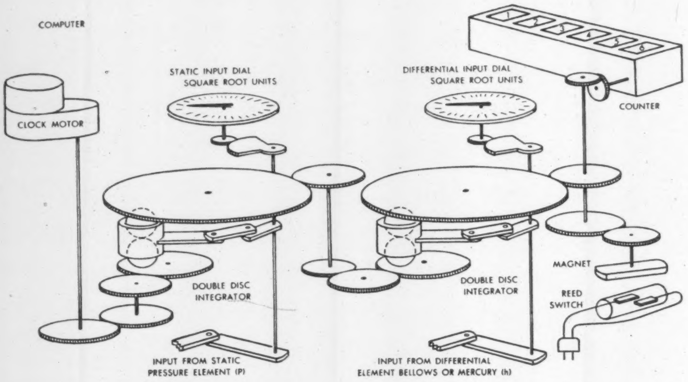
INSTRUMENTS and AUTOMATION Briefs

For this literature circle number on inquiry card.

Flow Computer

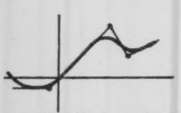
The computer extracts the square root and continuously integrates both differential and static pressures, without the use of cams or other intermittent devices . . . The mechanical circuit of the Librascope Flow Computer consists of a clock motor that drives a counter through a gear train and two double-disc integrators, connected in series. Each integrator is, in effect, a speed changer; the magnitude of the speed change depending on the displacement of the balls from the center of the lower disc. (*From new 4-page Cat.* 310398, *Librascope, Inc.,* 808 *Western Ave., Glendale, Calif.*)

For this literature circle **808** on inquiry card.

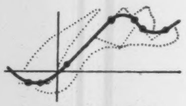

COMPUTER
CLOCK MOTOR
STATIC INPUT DIAL SQUARE ROOT UNITS
DIFFERENTIAL INPUT DIAL SQUARE ROOT UNITS
COUNTER
DOUBLE DISC INTEGRATOR
DOUBLE DISC INTEGRATOR
MAGNET
REED SWITCH
INPUT FROM STATIC PRESSURE ELEMENT (P)
INPUT FROM DIFFERENTIAL ELEMENT BELLOWS OR MERCURY (h)

Analog Computers

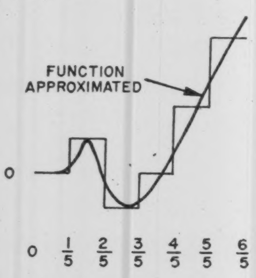
GAP/R Components (include) the Model FFR Arbitrary Function Component. The Model FFR causes the output to follow an assignable function of the input. It utilizes an approximation based on ten connected line-segments, each of which is independently adjustable as to slope, length, and amount of curvature between segments. The FFR features quadratic rounding (interpolation) of line-segment junctions, shift controls and a self-contained power supply.



Segments Roughly Approximated by Tangent Slopes



Local Curvatures Tailor Function Accurately



Output of Model DLS and the Function Fitted

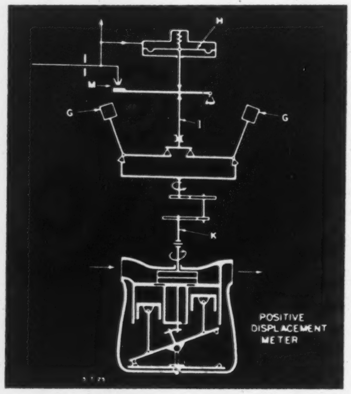
The Model DLS Delay Line Synthesizer is a five section delay line function synthesizer in which the output of each section may be delayed in time by an amount continuously adjustable from 10 milliseconds to one second. The time delay may be adjusted by a knob on the front of the control unit or by an external voltage.

The output of each section may have an amplitude of zero to 10 times (up to 50 volts) that of the input signal and may be combined in either sign with the outputs of the other sections . . .Functions of 50 milliseconds to 5 seconds duration may be synthesized by Model DLS in five segments. (*From new 16-page Bulletin "GAP/R Electronic Analog Computors," George A. Philbrick Researches, Inc.,* 230 *Congress St., Boston* 10, *Mass.*)

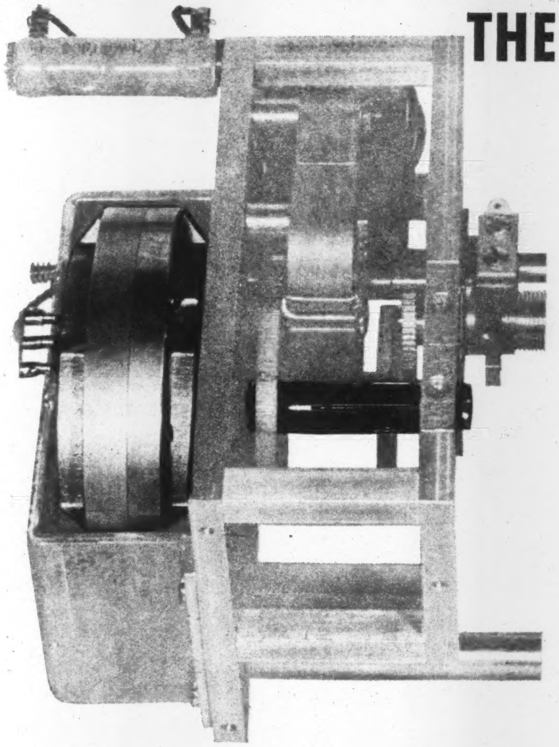
For this literature circle **809** on inquiry card.

Transometer

The Askania Transometer comprises a pneumatic signal transmitter and a positive displacement flow meter. The flow meter accurately measures the volumetric rate of flow, regardless of changes in viscosity, pressure or temperature, by means of pistons and cylinders. The cylinders act as measuring cups which count the metered fluid as the flow passes through the meter . . . The signal transmitter operates from the metering system and converts the mechanical rotary action of the flow meter to a pneu-


H
M
G
G
K
POSITIVE DISPLACEMENT METER

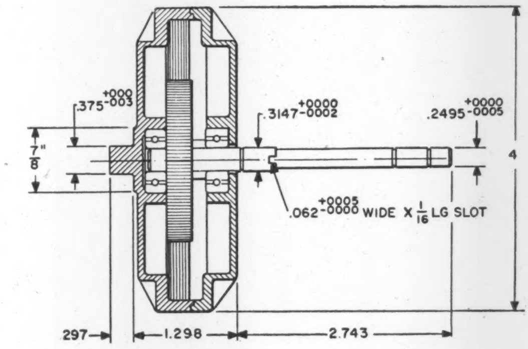
CONSTANT ANGULAR ROTATION FOR PRECISE SPEED CONTROL!

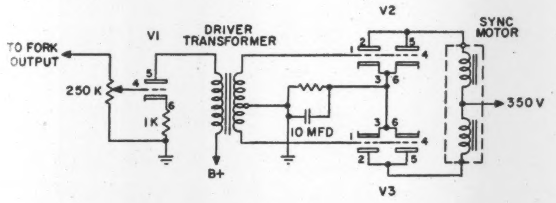


THE TIMES FACSIMILE MS-2 SYNCHRONOUS MOTOR

is a phonic wheel type motor capable of operating from vacuum tube amplifiers on signal from frequencies 60 to 4000 cps. It was designed specifically to provide the extremely accurate and invariable speed required for driving fork-synchronized facsimile equipment. The previous model (MS-1) has proved itself by years of continuous duty in communications service. Its unique characteristics will be found the answer to many problems involving the need for constant angular rotation or precise synchronization.

The Model MS-2 Motor can be operated single phase in the plate circuit of a single-ended amplifier or as a two-phase motor when driven by a push-pull amplifier. The latter is recommended since the two-phase connection runs quieter and provides more power with less heating. The motor current is approximately 75 milliamperes per phase. The power input may be as high as 20 watts.





NOTE: Tube types recommended for V2 and V3 are 6SN7GTB, 6BL7, BX7 and triode connected beam power pentodes. Selection should be ased on power requirements. Cathode resistor is selected to give the esired DC current through the motor windings.

Complete information and prices will be mailed promptly on request.

DESCRIPTION

TYPE — phonic wheel variable reluctance synchronous motor.

DIRECTION OF ROTATION — determined by start motor.

DRIVING FREQUENCIES — 60 to 4000 cps.

NUMBER OF PHASES — 2.

MAX. MOTOR CURRENT — 75 ma per phase.

MAX. POWER INPUT — 20 watts.

MAX. SYNC. TORQUE — 6 in. oz. at 1800 rpm.

MAX. POWER OUTPUT — up to 1/50 hp. depending on input frequency.

SYNC. SPEED — rpm = driving frequency when connected directly in amplifier plate circuit.
Rpm = 2 x driving frequency with AC only.

MAX. INDUCTANCE — .8 h.

MIN. INDUCTANCE — .4 h.

ROTOR INERTIA — 3.2 oz. in.^{2}

MAX. FREQUENCY ACCELERATION — 1000 cycles/sec./sec. from 500 through 2000 cps, no load.

DUTY CYCLE — continuous.

BEARINGS — class 7 precision ball bearings.

WEIGHT — 1½ lbs.

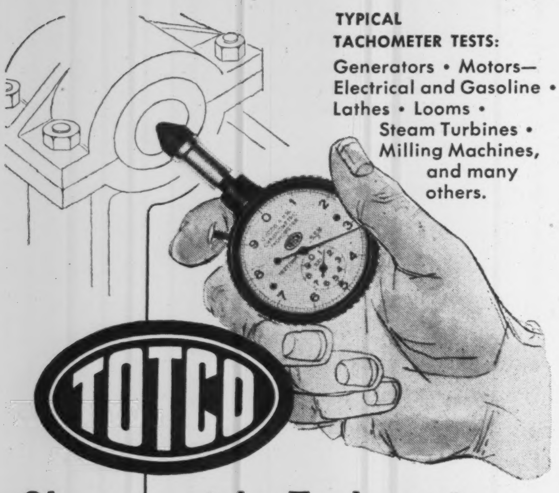
SUGGESTED USES — timing devices, facsimile, commutators, recorders, frequency servo units, variable frequency dividers.

TIMES FACSIMILE CORPORATION

540 West 58th Street, New York 19, N. Y. • 1523 L Street N. W., Washington 5, D. C.

For more information circle 169 on inquiry card.

TYPICAL TACHOMETER TESTS:
Generators • Motors—Electrical and Gasoline • Lathes • Looms • Steam Turbines • Milling Machines, and many others.



TOTCO

Chronometric Tachometers

Guarantee ACCURACY To $\frac{1}{10}$ of 1%

BUILT TO NAVY SPECIFICATIONS, Totco Tachometers measure with *guaranteed* accuracy.

PRECISION MANUFACTURE, EXCLUSIVE DESIGN, STURDY CONSTRUCTION insure trouble-free service, long life. Built-in timing mechanism.

ABSOLUTE GUARANTEE for one year against defects in material and workmanship.

TECHNICAL OIL TOOL CORPORATION
Manufacturers of Precision Instruments
1057 North La Brea Avenue, Los Angeles 38, California
For more information circle **170** on inquiry card.

BRIEFS—CONTINUED

matic signal which is a square root function of the flow. This signal can be employed for control purposes and also as an actuating signal for indicating and/or recording instruments calibrated in terms of flow.

Wherever oil is employed as a fuel, combustion control, multiple fuel summarization, furnace atmosphere control, and the control of total heat input—are most precisely and efficiently handled by using the Transomete as the flow-metering element. The easily read integrato on the Transometer provides a continuous evaluation o total fuel consumption for cost accounting or heat balanc calculations. Flow ranges from 5-100 gph to 300-300 gph. (*From new 8-page Bulletin* 301, *Askania Regulato Co.,* 240 *E. Ontario St., Chicago* 11, *Ill.*)

For this literature circle **810** on inquiry card.

Electronic Test Instruments

Basically similar to the well-known *-hp-* 522B, new 523 offers broadened frequency range of 10 cps to 1.1 MC Time interval coverage is also broadened—3 usec t 100,000 seconds or 27.8 hours. Period measurement i available from 0.00001 cps to 10 KC . . . Results are displayed instantly and automatically in direct-reading for on six panels numbered 0 to 9 . . . Display time is variabl from 0.1 second to 5 seconds or indefinitely.

Advantages: Direct frequency, period, or time interva readings; Basic accuracy ±1 count; stability 2 ppm pe week.

Use To Measure:

Frequency. Production quantities. Nuclear radiation Power line frequencies. Rps and rpm. Very low frequencies. Oscillator stability. Repetition rates. Weight, pressure, temperature and acceleration—remote if desired.

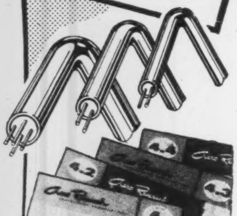
Time Interval, Period. Time between impulses. Puls

INSULATED WIRE
that will withstand 2000°F

Will last forever in service—eliminating costly replacement

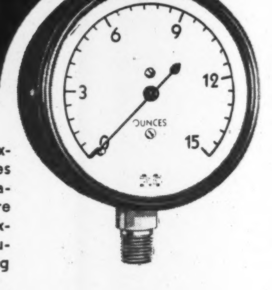
- Available in outside diameters of .04 to .32.
- One or more wires insulated with a pure mineral swaged into a metal tube.
- Can be sharply bent.
- Sheath can be welded without loss of insulation.
- Available in a variety of sheath metals with thermocouples and other wire materials.
- Complete thermocouple probes available using this material made to your requirements.

Write for Bulletin 4



Aero Research
INSTRUMENT COMPANY, INC.
315 NO. ABERDEEN STREET, CHICAGO 7, ILLINOIS
Sales Representatives throughout the United States and Canada
For more information circle **171** on inquiry card.

MARSHALLTOWN
DIAPHRAGM GAUGE
For Accurate Pressure Measurement in Ounces or Inches of Water



Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

MARSHALLTOWN MANUFACTURING CO.
MARSHALLTOWN 3, IOWA
For more information circle **172** on inquiry card.

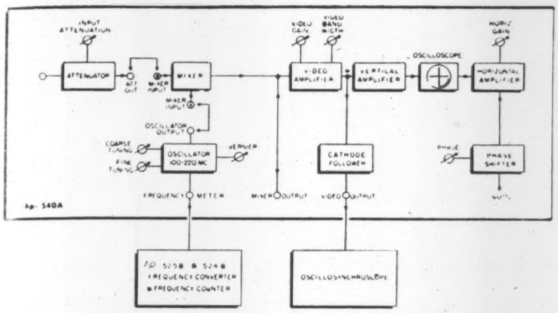

INPUT ATTENUATION
ATTENUATOR
ATT OUT
MIXER INPUT
MIXER
MIXER INPUT
OSCILLATOR OUTPUT
COARSE TUNING
FINE TUNING
OSCILLATOR 100-220 MC
VERNIER
FREQUENCY METER
MIXER OUTPUT
VIDEO GAIN
VIDEO BAND WIDTH
VIDEO AMPLIFIER
VERTICAL AMPLIFIER
OSCILLOSCOPE
HORIZ GAIN
HORIZONTAL AMPLIFIER
CATHODE FOLLOWER
VIDEO OUTPUT
PHASE
PHASE SHIFTER
hp 540A
hp 525B & 524B FREQUENCY CONVERTER & FREQUENCY COUNTER
OSCILLOSYNCHROSCOPE

Figure 1. *-hp-* 540A with 524B, 525B and oscillosynchroscope.

length. Shutter speeds. Projectile velocity. Relay operating times. Precise event timing. Interval stability. Frequency ratios. Phase delay.

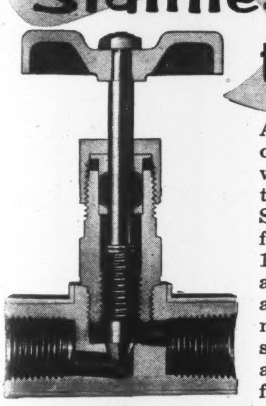
Development of the new -hp-540A Transfer Oscillator has made possible, for the first time, convenient frequency measurements far into the microwave region . . . Model 540A contains a highly stable, 100 to 220 MC oscillator generating harmonics to 12 KMC for comparison with the unknown. The comparison device is a diode mixer, amplifier, and built-in oscilloscope (see Figure). (*From new 20-page Supplement to Cat.* 22-*A* (1956), *which describes oscilloscopes, VTVM's, etc., Hewletter-Packard Co.,* 275 *Page Mill Rd., Palo Alto, Calif.*)

For this literature circle **811** on inquiry card.

Hydraulic Servovalve

Midwestern's Model 7 Single-Stage Servovalve utilizes a new valving principle that gives two-stage linearity with single-stage reliability. It is precision-manufactured for use in high-performance hydraulic or pneumatic power

Now . . . the Marsh Needle Valve in 416 Stainless Steel throughout!



All the superior dependability of the Marsh Needle Valve . . . with all the corrosion resistance and durability of 416 Stainless Steel! Guaranteed for working pressure up to 10,000 psi; equally efficient at any lower pressure. Globe and angle patterns with double female connections in 1/8" to 1" size range. Also globe and angle valves with male inlet, female outlet, 1/4" and 1/2" sizes.

For complete details, write for Bulletin No. NV-2.

MARSH INSTRUMENT CO.
Sales Affiliate of Jas. P. Marsh Corp.
Dept. 42, Skokie, Illinois
MARSH
"THE STANDARD OF ACCURACY"

Marsh Instrument & Valve Co. (Can.) Ltd., 8407 103rd St., Edmonton, Alta., Can.

For more information circle **173** on inquiry card.

SERVO ENGINEER

Challenging opportunities
in the field of controls
with MARTIN, builder of
the EARTH SATELLITE and
the INTERCONTINENTAL
BALLISTIC MISSILE.

AUTO-PILOTS
INERTIAL GUIDANCE
SATELLITE CONTROL SYSTEMS

Contact: **PROFESSIONAL EMPLOYMENT OFFICE**

MARTIN
Baltimore 3, Md.

ADVANCE IN HARDNESS TESTING with the NEW LEITZ MICRO HARDNESS TESTER

Even the most delicate and highly finished parts or tools may be tested for hardness WITHOUT DAMAGING or DEFORMING THE FINEST FINISH.

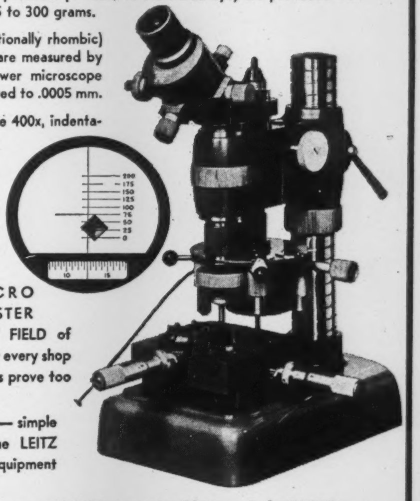
The diamond impressions (invisible to the naked eye) are produced with loads of only 15 to 300 grams.

The pyramid (or optionally rhombic) shaped impressions are measured by means of a 400-power microscope with reticule graduated to .0005 mm.

Microscope objective 400x, indentator as well as an extra 100x locating objective are mounted on a common revolving turret for quick indexing on the impression.

The LEITZ MICRO HARDNESS TESTER opens up a NEW FIELD of Hardness Testing for every shop where other methods prove too costly or unsuitable.

A reasonable price — simple operation, make the LEITZ TESTER essential equipment for any shop.


200
175
150
125
100
75
50
25
0
10
15

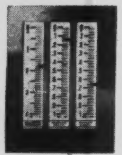
Write for our explicit 13-page Booklet — Code GLOLD

Geo. SCHERR OPTICAL TOOLS, Inc.
200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

For more information circle **174** on inquiry card.

It's ELLISON for accuracy!

STRAIGHT LINE DRAFT GAGES



Unit mechanism—readily accessible or removed. Non-parallax pointers. All diafram types have free-floating, long-life diafram. Bell type gages, Bulletin 122—Diafram type, Bulletin 124.

DIAL DRAFT GAGES

Unit mechanism readily accessible or removed. One, two or three pointers. Powerful movement on knife edge bearings. Ask for Bulletin 122.

INCLINED DRAFT GAGES

Constant zero under wide range in room temperature. Level and tube are replaceable in the field. Stationary and portable types. Also accessories and pitot tubes. Ask for Bulletin 109.

U-PATH STEAM CALORIMETER

Combines throttling, separating and re-evaporating calorimeter in a single unit. Accuracy within 2° F. Simple to use. Ask for Bulletin 118.

ELLISON DRAFT GAGE CO.

546 WEST MONROE STREET SINCE 1896 CHICAGO 6, Ill.

THE ELLISON LINE ALSO INCLUDES:

Draft Gages, Bell and Diafram—Inclined Draft Gages—Portable Inclined Vertical Tube Gages—Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube-Saturator Gages—U Gages—Stationary and Portable—Air Filter Gages—Dial and Inclined Tube Types—Pitot Tubes—U Path Steam Calorimeters—Portable Gas Analyzers-Orsat Type

For more information circle **175** on inquiry card.

RACINE

Since 1890 . . .
Sports and Industry
have relied on Racine
for fine TIMERS

Chronographs and Special Timers in All Price Ranges

Wherever Accuracy Counts!

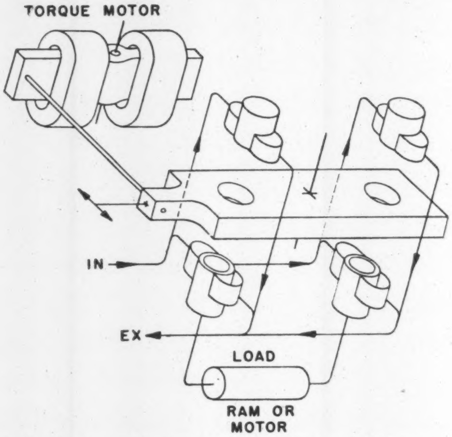
Write for latest Catalog featuring GALLET Timers

Available at Scientific Supply Firms. If unobtainable locally, write us.

JULES RACINE & COMPANY, INC.
Specialists in Fine Timers—Since 1890
20 WEST 47th STREET, NEW YORK 36, N. Y.

For more information circle **176** on inquiry card.

BRIEFS—CONTINUED



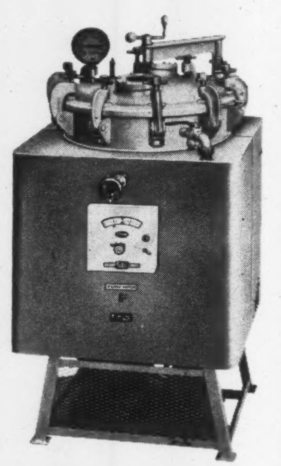
servo-systems . . . System Components: Midwestern's Model 12 Servoamplifier, Model 9 Torque Motor, Model 7 Servovalve, a 1-in-dia ram weighing 0.4 lb located 1 ft from servovalve, and an E-type translational ram pickoff. Max. power to load is approximately 2.3 hp; frequency response is within 5 db in magnitude to above 100 cps. (*From new 4-page Brochure MI-2-55-7, Midwestern Instruments, P. O. Box 7186, Tulsa, Okla.*)

For this literature circle **812** on inquiry card.

Dynamic Balancing Machine

The Dynograph Balancer is a precision electronic device to determine and indicate static or dynamic components

AUTOMATIZE
YOUR ENCAPSULATING



RED POINT Encapsulating machine is fully automatic in operation. It produces embedded or potted assemblies under vacuum.

Simple operation and consistent results are features of the RED POINT Encapsulating and Casting Machine. Autoclaves of the unit will hold pressures to 110 psi, while the vacuum system pumps down to 100 microns absolute pressure. Swing-away lid with observation window allows the operator to check work in progress.

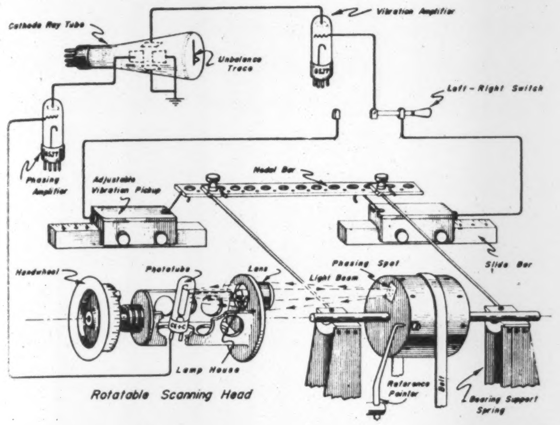
Temperature range of heated units is ambient to 400° F. and standard casting cup capacity is 194 cc, or 6.56 fluid oz. Either 8 or 22 casting cups are contained in a single unit.

Write, wire or telephone for further information.

RED POINT CORPORATION

1907 Riverside Drive
Glendale 1, Calif.
Telephone—THornwall 2-4895

For more information circle **177** on inquiry card.



of unbalance. Both amount and position of any existing unbalance in a rotor is determined in a few seconds, through a single reading of the "trace" on a cathode ray tube scale.

Unbalance of the spinning rotor causes flexibly mounted bearing structures to vibrate synchronously with the rotation. This vibration is transmitted to transducer units which convert the mechanical vibrations into similar electrical pulsations. These are then amplified and plotted on the vertical scale of a cathode ray tube. The scale reading, or vertical length, of the "trace" line is proportional to the amount of unbalance and may be calibrated to read in any practical correction unit. . . Phasing mark on rotor allows determination of position of unbalance by beam of light. *(From new 4-page folder "Annis Balancing Machines," R. B. Annis Co.,* 1101 *N. Delaware St., Indianapolis* 2, *Ind.)*

For this literature circle **813** on inquiry card.

TORQUE

applied by the inch ounce

ACTUAL SIZE

Available in these Torque Ranges

MODEL	CAPACITY
F80-I-G	0- 80 inch grams
F8-I-O	0- 8 inch ounces
F16-I-O	0- 16 inch ounces
F32-I-O	0- 32 inch ounces
F80-I-O	0- 80 inch ounces
F160-I-O	0-160 inch ounces

Inch pound models and larger foot pound ranges also available

sent on request

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

For more information circle **179** on inquiry card.

MILITARY REQUIREMENTS?
SPECIAL SERVICE CONDITIONS?

Cramer

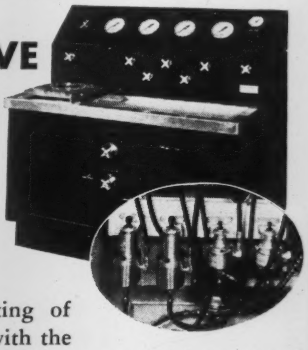
HERMETICALLY SEALED

- TIME DELAY RELAYS
- CYCLING TIMERS
- CIRCUIT RECLOSING RELAYS

- Meet stringent military specifications.
- High accuracy. Long service life.
- Available 50, 60, 400-cycle to 250V AC; 6-30V DC.
- Small size. Precision built.
- Individually timed and tested.
- Send for comprehensive technical Bulletin PB-410.

CRAMER CONTROLS
CORPORATION
BOX 5, CENTERBROOK, CONNECTICUT

For more information circle **178** on inquiry card.


SAFETY VALVE TEST STAND WITH "BUILT-IN" RELIABILITY

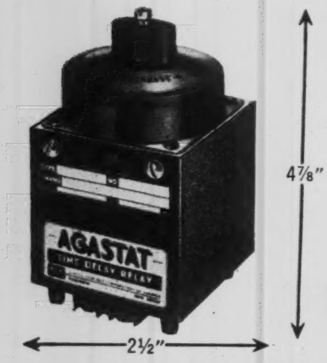
Completely reliable testing of safety valves is assured with the I. E. C. Test Stand. Four gauges give accurate readings, in the model illustrated, for pressures ranging between zero and 1000 pounds. Models are available for any ranges selected by the customer up to 10,000 pounds pressure. Adapter plates can be furnished to fit all sizes and types of safety valves. For complete information, please write for Bulletin 545.

Reliability of the Safety Valve Test Stand is guaranteed by the well known repeatability and accuracy of I.E.C. Gage Gards. They prevent the pressure being measured by each pressure gauge from exceeding its maximum.

INDUSTRIAL ENGINEERING CORP. IEC

INDUSTRIAL ENGINEERING CORPORATION
525 E. Woodbine, Louisville 8, Ky.

For more information circle **180** on inquiry card.



For after shutdown protection...

AGASTAT®

TIME DELAY RELAY

Allows operation of auxiliary protective devices* after operating cycle is stopped. Easily installed in any electrical line.

The AGASTAT is—

- light, versatile, dependable.
- instantaneous recycling.
- unaffected by voltage variations.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in models that offer delays on energizing and de-energizing, two step delays, manually-actuated time delay switch, remote push button control.

***WRITE for new 4-page application folder describing how one large company solved its after-operating problem. Address Dept. A21-89**

AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

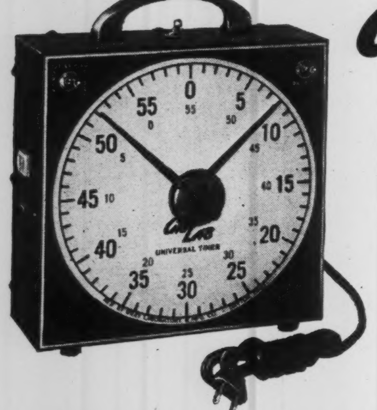
For more information circle **181** on inquiry card.

TIME YOUR TESTS IN SPLIT-SECONDS!

GRA LAB

ALL PURPOSE LABORATORY TIMERS

MODELS AT $21.95 TO $26.95



You can set the large 8" dial for any desired time period within an unusually wide range of 3600 possible settings, (ie., 1 sec. to 60 min., 1 min. to 60 hrs., etc.). At end of preset interval, alarm sounds and external load is automatically switched on or off.

Gra-Lab Micro Timers, **Electric Stop Clocks,** are available in 1/10 sec. or 1/1000 min. graduations for split-second measurements of elapsed time in laboratory or production operations. Price $37.50

WRITE FOR COMPLETE CATALOG!

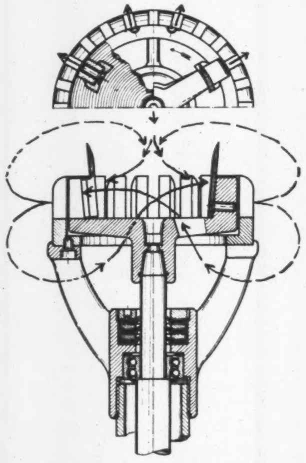
DIMCO-GRAY COMPANY

212 E. Sixth St.
DAYTON 2, OHIO

For more information circle **182** on inquiry card.

Wet Milling Mixer

In the POLYTRON Milling Heads rings of equally spaced shearing blades, fixed to disks, are arranged con-centrically around two shafts. The inner ring (in Milling Head No. 1)—or rings (in Milling Head No. 2)—of



shearing blades is fixed to a rotating member which i driven by a central shaft. The outer ring of shearin blades—or rings—is fixed to an outer member which i mounted on a stationary tubular shaft ... Subject to th number of shearing blade rings, degree of slot spacing be tween the blades and clearance between the rotor an stationary blades, substances can be either freely ad

ESS *Miniaturized* ELECTRIC EYES

SPECIALLY DESIGNED FOR INDUSTRY

The ESS "miniaturized" photo-units (light source and pickup) are designed to fit into those small impossible places. These units are engineered for performance in **monitoring, counting, positioning, registration** and **density.**

ESS "miniaturized" electric eyes can easily be assembled on ¼" pipe and fittings.

For more than 20 years ESS instruments have been used by industry—indicators; recorders; and controllers for smoke, dust and turbidity, etc.

Don't Guess... SPECIFY ESS!

Write for information

ELECTRONIC INSTRUMENTS and CONTROLS for INDUSTRY
TO KEEP OPERATIONS WITHIN LIMITATIONS

ESS INSTRUMENT COMPANY

96 SOUTH WASHINGTON AVENUE, BERGENFIELD 2, NEW JERSEY

For more information circle **183** on inquiry card.

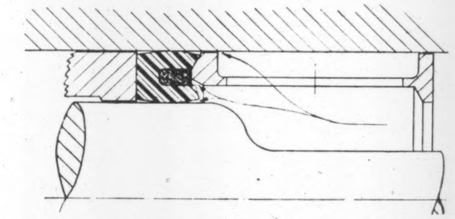
mixed into a vehicle without appreciable change to original particle size, or can be cut and broken up from sizable chunks to very small particles ranging in diameter from a few microns to a fraction of a micron.

Applications include: 1. Defibration. 2. Beating. 3. Mashing. 4. Homogenization. 5. Rapid dispersion and suspension. 6. Uniform dispersion. 7. Preparation of emulsions. 8. Acceleration. 9. Effective gas dispersion. (*From new 6-page Brochure "The Willems Polytron," Bronwill Scientific, Inc., P. O. Box 981, Rochester 3, N. Y.*)

For this literature circle **814** on inquiry card.

Air Control Valves

The basic design embodies a sliding stem moving through a series of specially designed packers which seal the air in an ON or OFF position without the use of metal seats . . . The area through the valve is equivalent to that of standard pipe. This full area permits unrestricted air flow.



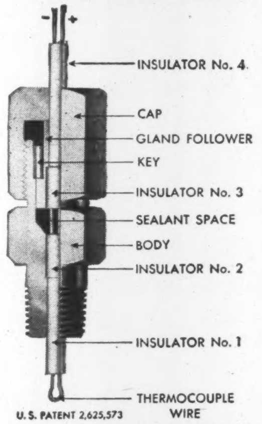
Five basic types of valves are offered in this catalog . . . The Two Way valve . . . The Three Way Open End Exhaust valve . . . The Three Way Piped Exhaust valve . . . The Four Way Open End Exhaust valve . . . The Four Way Piped Exhaust . . . (*From new 44-page Catalog 54SV, Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio.*)

For this literature circle **815** on inquiry card.

Fast Response

conax®

BARE WIRE THERMOCOUPLE GLANDS



provide the only simple positive method for sealing two or more bare wires at pressures from full vacuum to 20,000 psi.

Low mass, unshielded, bare wire thermocouples give almost instantaneous response to temperature changes assuring greater accuracy of measurement and control.

- **Temperature range—−300°F to +1850°F**
- **All stainless steel construction**
- **Complete range of sizes**
- **Available from stock**

WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS.

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For more information circle **185** on inquiry card.

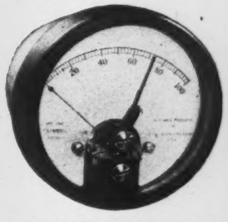
NEW METER-RELAYS

FROM 0-5 MICROAMPERES-UP

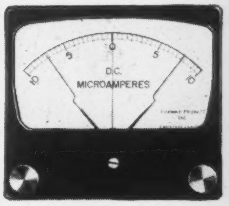
Ruggedized-Sealed, Black Bakelite, or Clear Plastic Cases

D'Arsonval indicating meters with built-in locking contacts for sensitive and accurate control or alarm

TRIP POINT ADJUSTABLE to any point of scale arc. Sensitive to changes as little as 1%. One contact carried on moving pointer. The other on an adjustable pointer. When two pointers meet, contacts close and lock. Holding coil is wound directly over moving coil, locking action is electro-magnetic. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully.



Model 255-C, Single Contact, High Limit, 0-10 Volts DC $42.50



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Ranges from 0-5 microamperes or 0-5 millivolts up, full scale. Temperature ranges from 0-300°F. (10 ohms external) have bimetal cold junction compensation. **Standard Contact Rating** 5 to 25 milliamperes DC. Can be built up to 100 milliamperes DC. **Ruggedized-Sealed** metal cases are 2½", 3½" and 4½" round, shock-mounted, gasket-sealed. **Black Bakelite** case, 4½" rectangular. **Clear Plastic cases** are 2½", 3¾", and 4½" rectangular. Maximum visibility and lower cost.

Panel meters and indicating pyrometers are also available in ruggedized-sealed, black bakelite or clear plastic cases. New 40-page catalog lists prices and specifications for meter-relays, meters, pyrometers and automatic controls using meter-relays. Write for Catalog 4-A, **Assembly Products Inc., Chesterland 10, Ohio.** HAmilton 3-4436 (West Coast: Desert Hot Springs 10, Calif. Phone: 4-3133)

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For more information circle **184** on inquiry card.

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MODEL 1010
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- **Tests Resistors, Condensers, Inductors**
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SPECIFICATIONS

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Component Voltage At Balance....**1 volt**
Frequency . . . Either 1,000 C.P.S., or 10,000 C.P.S.
Full Scale Ranges . . . ±5%, ±10%, ±20%
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Resistance - - - 5 ohms - 5 megohms
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A PORTABLE MILLIVOLT POTENTIOMETER WITH LABORATORY ACCURACY

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REFERENCE JUNCTION COMPENSATION SET ON MAIN SCALE TO MAIN SCALE ACCURACY.

SPOT-LIGHT GALVANOMETER, SENSITIVITY 3 MICRO-VOLTS PER DIVISION.

ACCURACY ±.01MV ON LOW & ±.05MV ON HIGH RANGE

Write For Bulletin E-18

GRAY INSTRUMENT COMPANY
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MERCOID
DIFFERENTIAL PRESSURE
CONTROLS

Equipped with
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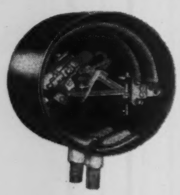
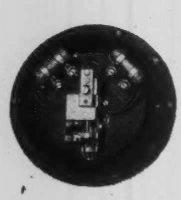
TO "MAKE" OR "BREAK" AN ELECTRICAL CIRCUIT ON CHANGES IN THE DIFFERENCE BETWEEN TWO PRESSURES



← FOR HIGH PRESSURES
Bourdon Tube Operated

Series BB: Operating ranges from 0-60 psi to 2,500 psi., with sensitivities varying from 0.4" to 50 psi.
Write for bulletin No. 15



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Diaphragm Operated

Extremely sensitive, for air or gas. Series PQ: Operating ranges (inches of water) 6.0" vac. to 6.0" press. (sensitivity .03",) and 30.0" vac. to 30.0" press. (sensitivity 0.1" to 0.02").
Write for Bulletin No. 14

THE MERCOID CORPORATION
4201 Belmont Avenue, Chicago 41, Illinois

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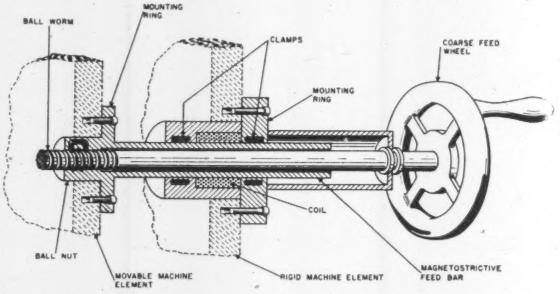
BRIEFS—CONTINUED

The Inchworm Motor

The Inchworm Motor is a linear actuator . . . a powerful feed mechanism that is accurately controllable in the range of microinches.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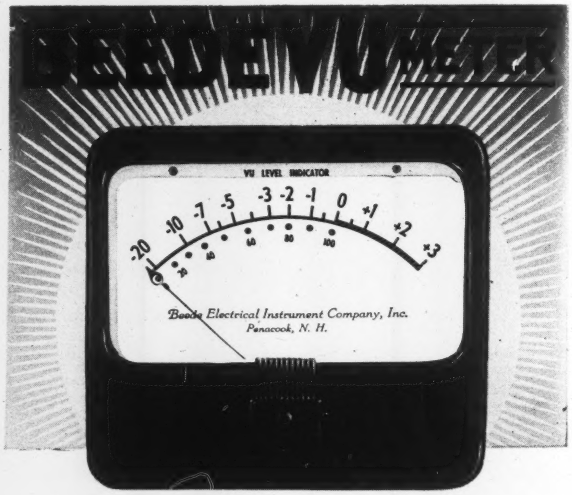
CLAMPS
COARSE FEED WHEEL
MOUNTING RING
COIL
BALL NUT
MOVABLE MACHINE ELEMENT
RIGID MACHINE ELEMENT
MAGNETOSTRICTIVE FEED BAR

Employing a physical phenomenon called the magnet strictive effect, the armature of the Inchworm moto shrinks under the influence of an electromagnetic fiel snapping back to original size when the magnetic fiel is de-energized. A pair of clamps cooperate with th armature to convert the expansion and contraction undulations into forward or backward motion, reversing o demand without backlash.

The magnetostrictive armature is supported in a pai of coaxial clamps (A,B) spaced to provide a desired maximum step size. Motion is produced by magnetically shrinking the armature while clamp (B) is locked and clamp (A) unlocked. This moves the left end of the armature to th right. Clamp (A) is then locked, clamp (B) released an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the armature expanded by removing the magnetic field. Now, the right end of the armature has moved to the right and a net motion between the two members has occurred. (*From new 8-page Booklet "An Introduction to the Inchworm Motor," Airborne Instruments Laboratory, Inc., Mineola, L. I., N. Y.*)

For this literature circle **816** on inquiry card.

Condenser Microphones

It can be seen from the described theory and experiments that the harmonic distortion in condenser microphones actually is smaller than found from the formula $d_2 = 50 \times e/E_0$.

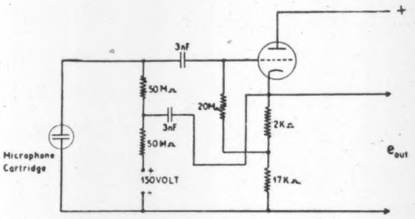
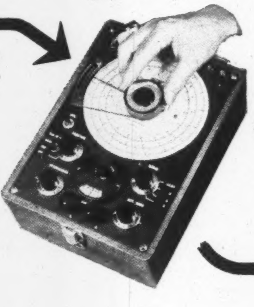


Fig. 8. Circuit diagram of the cathode-follower employed in Condenser Microphone Type 4111.

The dependency upon frequency and sound pressure shows that a large amount of harmonic distortion will only be present at very low frequencies and at high sound pressures, so that, at normal operating conditions, this type of distortion will be almost negligible. (*From new 16-page "Technical Revue," No. 3, July 1955, Bruel & Kjaer, represented by Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.*)

For this literature circle **817** on inquiry card.



The only portable potentiometer pyrometer with interchangeable direct-reading scales

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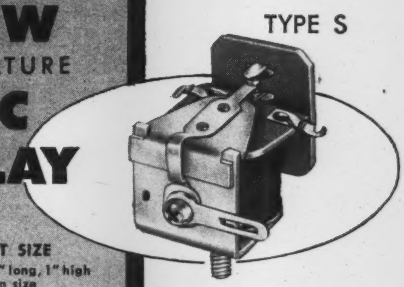
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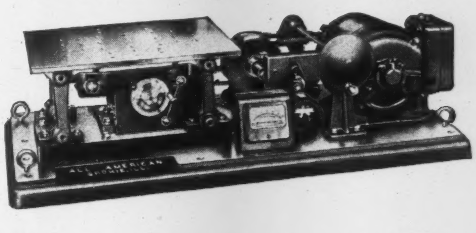
Range Selector Is Highlight Of All American Model 150 HLA-D Vibration Fatigue Test Machine



This machine subjects parts or assemblies, up to 150 lbs. in weight, to a comprehensive vibration fatigue test. It has a 50% overload safety factor. Vibration in simple harmonic motion is produced horizontally. Displacement (double amplitude) is adjustable from 0" to 125". Automatic Range Selector controls acceleration and deceleration. From 10 cycles per second frequency may be increased uniformly to 60 c.p.s. and then decreased to 10 c.p.s. Any desired range within the total may be selected. Selector can be switched off and frequency held at any c.p.s.

Recommended for testing aircraft, electronic, electrical, mechanical or optical parts or components. One of 7 models. Send for Catalog F, containing helpful data, nomograph chart and listing typical users. Write to

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INSTRUMENTS and AUTOMATION

New Literature

AUTOMATION

Automatic Positioning Table. New 2-page bulletin describes maker's automatic positioning table controlled by tape for repetitive runs in light manufacturing. New 8-page reprint presents application of positioning to turret lathe operations.—Binotrol Div., Barnes Engrg. Co., Stamford, Conn.

Circle **601** on inquiry card.

Combustion Control. New 20-page price manual, Bulletin CG-71, describes line of maker's products—flame safeguards, etc.—Combustion Control Div., Electronics Corp. of America, 718 Beacon St., Boston 15, Mass.

Circle **602** on inquiry card.

Remote Control System. New 4-page Bulletin describes maker's remote control system that uses polarized voltage pulses for two-position discreet operation of pumps, valves, doors, etc.—Sparton Control Systems Div., The Sparks-Withington Co., Jackson, Mich.

Circle **603** on inquiry card.

Automatic Parts Feeder. New 4-page bulletin presents maker's "Feed-A-Matic", a parts feeder which feeds up to 200,000 items per hour.—U. S. Engineering Co., 40-24 22nd St., L. I. City 1, N. Y.

Circle **604** on inquiry card.

VALVES

Water Mixing Valves. New 4-page Bulletin 362 describes maker's "Hydroguards" Type N-45 and N-125 which thermostatically mix hot and cold water to deliver a blend at the desired temperatures.—Powers Regulator Co., Skokie, Ill.

Circle **605** on inquiry card.

Valves. New 18-page Bulletin 700 presents maker's diaphragm-actuated M-series valves designed to regulate flow of gases and fluids.—Natural Gas Equipment Inc., 804 So. Fair Oaks Ave., Pasadena 2, Calif.

Circle **606** on inquiry card.

Reducing Valve. New 2-page Bulletin 5565C presents dimension drawings and classification table for maker's direct-operated pressure-reducing valve.—Leslie Co., Lyndhurst, N. J.

Circle **607** on inquiry card.

Valves. New 4-page Bulletin 100 presents miniature packless valves and manifolds. New 4-page bulletin presents packless demi valves and diaphragm operated "Bantam" valves.—George W. Dahl Co., Inc., 430 High St., Bristol, Rhode Island.

Circle **608** on inquiry card.

Solenoid Valves. New 2-page bulletin describes maker's new bronze and stainless steel, direct-acting, solenoid valves.—J. D. Gould Co., 730 E. Washington St., Indianapolis 2, Ind.

Circle **609** on inquiry card.

Butterfly Valves. Eight New 2-page Bulletins, No. 574 A,B,C,D,575,-576,577 and 578 describe maker's rubber-seated type butterfly valves for water service.—W. S. Rockwell Co., 200 Eliot St., Fairfield, Conn.

Circle **610** on inquiry card.

Metering Valves. New 4-page bulletin describes maker's non-leak, finger-tip controlled metering valves for gases and liquids.—Robbins and Associates, 1735 W. Florence Ave., Los Angeles 47, Calif.

Circle **611** on inquiry card.

Hand Valves. New 2-page Circular No. 605 describes maker's bronze globe valve "LQ600" now available in two complete series for a wide range of pressure applications.—Lunkenheimer Co., Cincinnati, Ohio.

Circle **612** on inquiry card.

Valves. New 16-page Catalog No. 700 presents characteristics on maker's line of forged steel valves.—Velan Steam Specialities Inc., 37 So. River Street, Plattsburg, N. Y.

Circle **613** on inquiry card.

Control Valve. New 4-page Bulletin 5813 presents maker's single control valve that replaces nest of individual valves for cyclic control of ion exchange equipment such as demineralizers, and pressure filters.—Cochrane Corp., 17 St. and Allegheny Ave., Phila. 32, Pa.

Circle **614** on inquiry card.

Valves. New 4-page pamphlet presents maker's "Quick-Dump" ¼", 3-way, multi-purpose valves for applications up to 125 psi, available as solenoid, cam, pedal, lever or button operated type.—Humphrey Products, Kalamazoo, Mich.

Circle **615** on inquiry card.

Jacketed Valves, Fittings, Piping. New 26-page Catalog 356 presents application data and specs for maker's line of jacketed valves, fittings and piping.—Parks-Cramer Co., P.O. Box 444, Fitchburg 22, Mass.

Circle **616** on inquiry card.

Pneumatic Valve Actuators. New 4-page Bulletin B-1020-5 presents maker's pneumatic spring and diaphragm "Conomotor" actuators for use with butterfly valves, gas and oil burner valves and dampers.—Conoflow Corp., 2100 Arch St., Phila. 3, Pa.

Circle **617** on inquiry card.

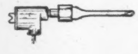
Electro-Hydraulic Pilot Valve. New 6-page Specification Sheet GH-300 presents maker's d-c current actuated, two-stage, high-capacity electro-hydraulic pilot valve.—Hagan Corp., Pittsburgh 30, Pa.

Circle **618** on inquiry card.

MOTORS

Gearhead Motors. New 4-page Bulletin F-4344-3 presents maker's permanent magnet type d-c motors which can be supplied with gearheads for maximum torque output of from 5 to 10 pound-inches.—Barber-Colman Co., Rockford, Ill.

Circle **619** on inquiry card.



TEMPERATURE

Thermistors. New 12-page Catalog EMC-1 describes maker's line of thermistors, including bead, rod, disc, and washer types, and built-up assemblies.—Fenwal Electronics, Inc., Framingham, Mass.

Circle **620** on inquiry card.

Thermistor Elements. New 4-page bulletin describes maker's thermistor heat detector cells available in three models and a variety of standard sizes.—Servo Corp. of America, New Hyde Park, N.Y.

Circle **621** on inquiry card.

Thermistor Bolometers, New 4-page Technical Bulletin TB 1300-1 gives characteristics and circuit design considerations of maker's thermistor heat detector cells.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N.Y.

Circle **622** on inquiry card.

Dial Thermometers. New 8-page Bulletin 149 describes maker's bimetal thermometers with anti-parallax maxivision dial.—Manning, Maxwell & Moore, Stratford, Conn.

Circle **623** on inquiry card.

Pyrometers. New 8-page Catalog 175 describes maker's optical, micro-optical, radiation, immersion, surface and indicating pyrometers.—The Pyrometer Instrument Co., Inc., Bergenfield, N.J.

Circle **624** on inquiry card.

Temperature Switches. New 4-page Bulletin S-AT-1 describes maker's complete line of snap-action "Thermoswitch" controls and lists physical, electrical and performance specifications.—Fenwal Inc., Ashland, Mass.

Circle **625** on inquiry card.

Temperature Switches. New 4-page Catalog ML-1 presents physical, electrical and performance data of maker's "Thermoswitch" units.—Fenwal Inc., Ashland, Mass.

Circle **626** on inquiry card.

Pyrometer Indicators. New 8-page Catalog 25-3 describes maker's millivoltmeter multiple-point-type pyrometer indicators.—Thermo Electric Co., Inc., Rochelle Park P.O., Saddle Brook, N.J.

Circle **627** on inquiry card.

Thermostats. New 4-page Bulletin 8400 illustrates maker's line of thermostats, including adjustable, manual reset, semi-enclosed, hermetically sealed, etc.—Stevens Mfg. Co., Inc., P. O. Box 1007, Mansfield, Ohio.

Circle **628** on inquiry card.

Thermocouple Restorer. New 4-page reprint features article on use of maker's thermocouple restorer on furnace for annealing steel coils.—The Peerless Electric Co., Warren, Ohio.

Circle **629** on inquiry card.

Temperature Controls. New 8-page condensed catalog reviews maker's line of temperature controls and allied equipment for industrial heating and refrigeration.—The Partlow Corp., 2 Campion Rd., New Hartford, N. Y.

Circle **630** on inquiry card.

Thermocouple Head. New 2-page leaflet describes maker's miniature thermocouple head with angle bracket and operating temperatures up to 500°F.—Marlin Mfg. Corp., 12410 Triskett Road, Cleveland 11, Ohio.

Circle **631** on inquiry card.

Temperature Control. New 2-page bulletin presents maker's automatic temperature controller that scans mirrored meter face with a beam of light and detects position of the pyrometer needle.—The Jelrus Co., Inc., 136 W. 52 St., New York 19, N.Y.

Circle **632** on inquiry card.

Fire Alarm Systems. New 10-page reprint is "Guide for Preparing Fire Alarm System Specifications."—Edwards Co., Dept. PA-9, Norwalk, Conn.

Circle **633** on inquiry card.

PRESSURE, WEIGHT

Leak Detector. New 6-page Bulletin 483 presents specs and applications for maker's leak detector for locating leaks in pressure, vacuum and hermetically sealed systems.—Process Instruments Dept., Beckman Instruments, Inc., Fullerton, Calif.

Circle **634** on inquiry card.

Leak Detector. New 4-page Bulletin 1830 describes maker's Type 24-210 portable leak detector for testing evacuated or pressurized systems by the mass spectrometer principle.—Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

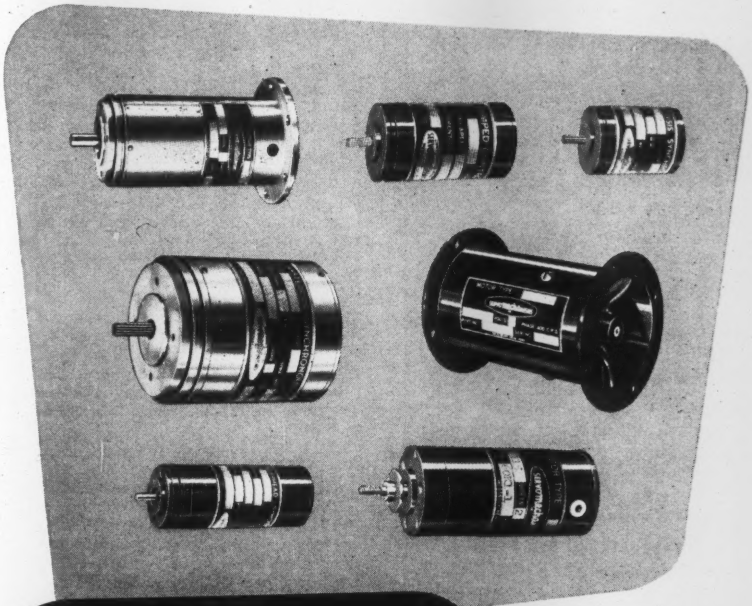
Circle **635** on inquiry card.

Vacuum Pump. New 4-page Bulletin No. 4356 describes design and advantages of new radiator air-cooled lubrication system in two high vacuum pumps.—Leiman Bros., Inc., 146-81 Christie St., Newark 5, N.J.

Circle **636** on inquiry card.

Pressure Pickups. New 2-page Bulletin CEC-1539B describes type 4-311 pressure pickup with 10 to 5,000 psig ranges for applications with severe vibration, acceleration and ambient-temperature variations. New 2-page Bulletin CEC-1541A describes type -313 pressure pickup with absolute or gage models from 250 to 5,000 psi ranges. New 2-page Bulletin CEC-

New EXPANDED LINE OF
400 CYCLE INSTRUMENT MOTORS



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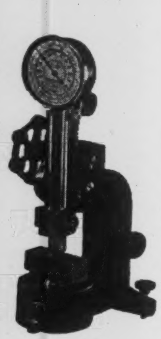

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For more information circle **195** on inquiry card.

NEW LITERATURE

1553A describes type 4-314 pressure pickup with absolute or gage models from 1,000 to 5,000 psi ranges threaded for standard fittings.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **637** on inquiry card.

Pressure Pickup. New 2-page Bulletin 1568 presents maker's pressure pickup, Type 4-316, capable of continuous operation at 600°F.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **638** on inquiry card.

Vacuum and Pressure Gages. New 4-page Catalog 140 describes maker's vacuum and pressure gages which use the principle of noble-metal compensated thermopiles.—Hastings-Raydist, Inc., Hampton, Va.

Circle **639** on inquiry card.

Diaphragm Manometer. New 2-page leaflet describes maker's diaphragm manometer for measuring vacuum, pressure and differential pressure.—Taylor Instrument Co., Rochester 1, N.Y.

Circle **640** on inquiry card.

High Pressure Equipment. New 2-page Leaflet No. 155 describes maker's additions to the regular HIP line including autoclaves, generators, reactors, and gages.—High Pressure Equipment Co., Inc., Erie, Pa.

Circle **641** on inquiry card.

Pressure Transducer. New 2-page leaflet presents maker's piezoelectric pressure transducer Model LC-33 which employs sensitive elements of the lead zirconate formulations.—Atlantic Research Corp., Alexandria, Va.

Circle **642** on inquiry card.

Pressure Transducer. New 8-page bulletin describes maker's new "Dynagage" DG-400 for measuring static and dynamic pressures at 6000°F.—Photocon Research Products, 421 N. Foothill Blvd., Pasadena 8, Calif.

Circle **643** on inquiry card.

Vacuum Gage. New 1-page leaflet describes maker's thermocouple vacuum gage with voltage stabilized circuit.—Arthur F. Smith Co., Rochester 3, N. Y.

Circle **644** on inquiry card.

Dynamometer. New 4-page bulletin presents maker's precision-dynamometer for determining the force required to actuate delicate mechanisms.—George Scherr Co., Inc., 200 Lafayette Street, N. Y. 12, N. Y.

Circle **645** on inquiry card.

Torque Testers. New 4-page Bulletin 711 describes maker's running torque testers and dynamometers for fractional hp motors with capacities from 1 in-oz to 320 in-lb.—John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.

Circle **646** on inquiry card.

Floor Scales. New 4-page bulletin presents maker's heavy duty floor scales with double pendulum mechanism and unit weight mechanism.—Toledo Scale Co., Toledo 1, Ohio.

Circle **647** on inquiry card.

Remote Digital Weight. New 8-page bulletin describes maker's remote digital weighing equipment plus automatic electric typewriters, tape punch, and card punch for tabulation.—Toledo Scale Co., Toledo, Ohio.

Circle **648** on inquiry card.

Automatic Scale. New 4-page Technical Reference 56B describes maker's high-speed, automatic cottonseed scale in cotton gin operation.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle **649** on inquiry card.

Shipping Scale. New 4-page Bulletin 1148A presents maker's automatic heavy duty grain shipping scale.—Richardson Scale Co., Clifton, N. J.

Circle **650** on inquiry card.

Automatic Coal Scale. New 16-page Bulletin 0352A presents maker's automatic coal scales, belt feeders, hoppers and other accessories for coal fired boilers.—Richardson Scale Co., Clifton, N. J.

Circle **651** on inquiry card.

FLOW

Flow Transmitter. New 6-page bulletin presents maker's new high-hea differential meters which transmi linear flow signals.—Bailey Mete Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **652** on inquiry card.

High-Capacity Flowmeter. New 4-page Catalog 10-A-43 describes maker's high-capacity variable area flowmeter with linear calibration in all-metal construction.—Fischer & Porter Co., Hatboro, Pa.

Circle **653** on inquiry card.

Pneumatic Ratio Relay. New 2-page Specification Sheet SP-4315 describes maker's ratio relay Model 3-15 for panel mounting with handwhee adjustment for control of fuel/ai ratio, etc.—Hagan Corp., Pittsburg 30, Pa.

Circle **654** on inquiry card.

Chlorinators. New 4-page leafle presents maker's variable orifice chlorinators featuring new principle fo accurately feeding chlorine gas.—Wallace & Tiernan Inc., 25 Main St. Belleville 9, N. J.

Circle **655** on inquiry card.

Flow Regulators. New 6-page Bulletin 561 describes makers direct-acting flow rate regulators for liquids, slurries, and suspensions.—W. A. Kates Co., 430 Waukegan Road, Deerfield, Ill.

Circle **656** on inquiry card.

Flow Vibrators. New 6-page bulletin describes maker's alternating vibrators that develop torque rathe than thrust for bulk material handling.—Eriez Mfg. Co., Erie 6, Pa.

Circle **657** on inquiry card.

Vibrators. New 6-page bulletin describes maker's vibrators, and characteristics that develop alternating torque rather than thrust for bulk material handling—Eriez Manufacturing Company, Erie 6, Pa.
Circle **658** on inquiry card.

Bulk Material Flow and Level. New 2-page Technical Reference 55D presents three models of maker's automatic sensing devices for bulk materials.—Richardson Scale Co., Van Houten Ave., Clifton, N.J.
Circle **659** on inquiry card.

Hydraulic Systems. New 20-page Bulletin M5101A describes oil-hydraulic systems and components for mobile units such as trucks, buses, construction machinery, material handling, agricultural and allied equipment.—Vickers, Inc., Box 302, Detroit 32, Mich.
Circle **660** on inquiry card.

Sight Glass. New 4-page folder describes maker's "PresSure", special lens and mounting for use in chemical, pharmaceutical, petroleum, food processing industries, etc.—"PresSure" Products Co., P.O. Box 424, Charleston 22, W.V.
Circle **661** on inquiry card.

AIRCRAFT

Gyros and Potentiometers. New 4-page leaflet #380 describes specifications and characteristics of maker's available compensated vertical gyros, ruggedized fully floated gyros and directional gyros.—Gyromechanisms Div., Norden-Ketay Corp., Halesite, L.I., N.Y.
Circle **662** on inquiry card.

Automatic Pilot. New 8-page Bulletin F-797 describes maker's tubeless automatic pilot engineered expressly for small planes.—Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N.J.
Circle **663** on inquiry card.

Control Beacon. New 4-page brochure describes maker's air traffic control beacon for automatic identification and air traffic safety.—Stewart-Warner Electronics, 1300 N. Kostner Ave., Chicago 51, Ill.
Circle **664** on inquiry card.

VISCOSITY

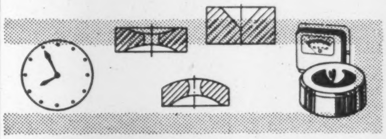
Viscometer. New 8-page Bulletin MSP-125A describes maker's new approach to rotational viscometers producing high rates of shear.—Hagan Corp., Pittsburgh 30, Pa.
Circle **665** on inquiry card.

Viscometer. New 8-page Bulletin MYP-509A describes the operation and maintenance of the maker's viscometer.—Hagan Corp., Pittsburgh 30, Pa.
Circle **666** on inquiry card.

AIR, MOISTURE

Moisture Indicators. New 2-page bulletin illustrates "Full-View" sight flow moisture indicators that change color when moisture is present in gas or air lines.—Jacoby-Tarbox Corp., 8 8 Nepperhan Ave., Yonkers, N. Y.
Circle **667** on inquiry card.

Air Sampler. New 2-page Bulletin 10-2 describes "Fixt-Flo" air sam-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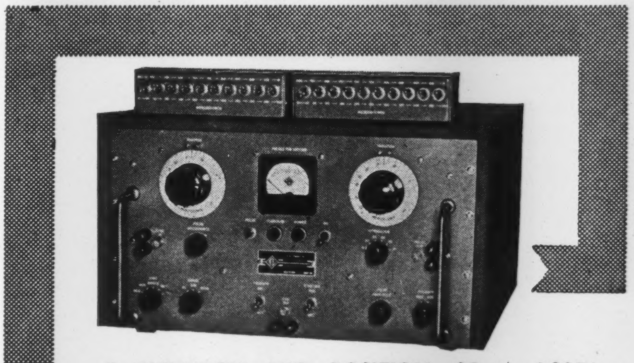
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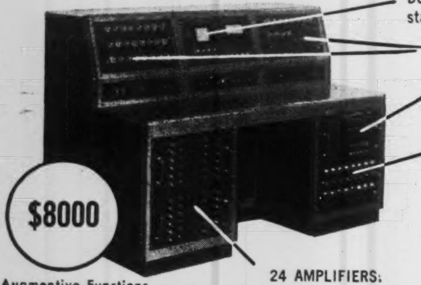

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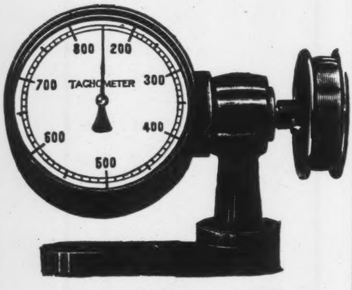

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pler designed to collect large samples of contaminants for air pollution analysis.—Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle **668** on inquiry card.

Atmospheric Regeneration Dryer. New 2-page data sheet presents maker's atmospheric regeneration dryers models 50 A to 200 A for compressed air or gas.—Industrol Corp., 472 Westfield Ave., East, Roselle Park, N. J.

Circle **669** on inquiry card.

Steam Purifiers. New 8-page descriptive Bulletin G10M presents maker's "Hi-eF" purifiers for removing liquids, solids, oil or dirt from live or exhaust steam.—V. D. Anderson Co., 1935 West 96th St., Cleveland 2, Ohio.

Circle **670** on inquiry card.

VIBRATION

Vibration Calibrator. New 2-page Technical Bulletin 501 describes maker's vibration calibrator Model 501 for calibrating vibration pick-ups or measuring vibration of non-magnetic, metallic surfaces.—ACF Electronics, 800 North Pitt St., Alexandria, Va.

Circle **671** on inquiry card.

Vibration Testing. New 8-page issue of "Vibration Notebook" (Vol 2, No. 1) describes vibration testing under rarefied atmospheric conditions and temperature extremes.—MB Mfg. Co., 1060 State St., New Haven, Conn.

Circle **672** on inquiry card.

Shock and Vibration Isolators. New 8-page Bulletin 56-02 describes maker's cup-mount series of shock and vibration isolators for shipboard, mobile and industrial service.—Barry Controls Inc., 918 Pleasant St., Watertown 72, Mass.

Circle **673** on inquiry card.

SPEED, FREQUENCY

Speed Recorders. New 4-page Bulletin ND46-27(1) describes maker's "Speedomax G" recorders for measurement of rotational and linear speeds and includes standard and explosion-resistant tachometers.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **674** on inquiry card.

Stroboscope. New 2-page Catalog Sheet 18A-1 combines description and instructions on maker's inexpensive 60-cycle stroboscope, Model 18A.—Berkshire Laboratories, Greenville, N. H.

Circle **675** on inquiry card.

TESTING, INSPECTION

Non-Destructive Testing. New 16-page bulletin describes maker's methods and equipment used for non-destructive testing.—Magnaflux Corp., 7300 West Lawrence Ave., Chicago 31, Ill.

Circle **676** on inquiry card.

Metal Analyzer. New 2-page Catalog Sheet ED 11706 presents "Metal Monitor" that determines variations in composition, hardness, grain size, plating thickness or adhesion between metal samples or on a single piece of metal.—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **677** on inquiry card.

Porosimeter. New 2-page Bulletin 2282 presents maker's Porosimeter for pore structure analysis, which measures sizes of pores from 0.1 mm to 0.06 microns and pore volumes as small as 0.0005 ml at each pore diameter.—American Instrument Co., Inc., Silver Spring, Md.

Circle **678** on inquiry card.

Wear Tester. New 4-page Bulletin 16 describes maker's wear tester for paints, varnishes, lacquers, linoleums and other materials.—Gardner Laboratory, Inc., 5521 Landy Lane, Bethesda 14, Md.

Circle **679** on inquiry card.

Gloss Recorder. New 4-page Bulletin 167 describes the maker's automatic gloss, color and reflectance recorder which utilizes a modified Varian model G-10 graphic recording unit.—Gardner Laboratory Inc., Bethesda 14, Md.

Circle **680** on inquiry card.

Portable Hardness Tester. New 2-page Bulletin F-1689-2BK presents data on Barber-Colman's portable hardness tester for aluminum, aluminum alloys, soft metals and plastics. —Gardner Laboratory, Inc., Bethesda 14, Md.

Circle **681** on inquiry card.

Magnetic Core Testing. New 16-page Bulletin 136 describes pulse control systems for testing magnetic cores by digital techniques.—Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Phila. 7, Pa.

Circle **682** on inquiry card.

Testing Service. New 4-page Bulletin PT-4 describes range of environmental and functional testing facilities available for testing electronic, hydraulic and mechanical devices. New 4-page Bulletin presents services available for development of these same devices.—Parameters, Inc., 195 Herricks Rd., New Hyde Park, N. Y.

Circle **683** on inquiry card.

Paper Sampler. New 2-page bulletin describes "Pro-tak-tor" that protects paper samples from moisture surges between sampling and testing. —Paper Industry Instrument Co., 3398 Ingleside Road, Cleveland 22, Ohio.

Circle **684** on inquiry card.

NUCLEONICS

Radioisotopes. Revised 4-page Bulletin 381 describes maker's carrier-free radioisotope sales program of NSEC and new isotopes, some offered for first time to industrial and scientific laboratories.—Nuclear Science and Engineering Corp., Pittsburgh 36, Pa.

Circle **685** on inquiry card.

Scintillation Counter. New 2-page Bulletin presents maker's thallium ac-

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NEW LITERATURE

tivated sodium iodide scintillation counters with high sensitivity and high resolution for spectrometry.—Fretco Inc., 406 N. Craig St., Pittsburgh 13, Pa.

Circle **686** on inquiry card.

Neutron Monitor. New 2-page specification sheet describes maker's Model 2715 "Nemo", a portable battery operated survey meter for measurement of thermal and fast neutron fluxes.—Nuclear-Chicago, 229 W. Erie St., Chicago 10, Ill.

Circle **687** on inquiry card.

Scintillation Detector. New 2-page bulletin gives specifications of maker's "Well-Type" scintillation detector.—Nuclear Instrument and Chemical Corp., 223 West Erie St., Chicago 10, Ill.

Circle **688** on inquiry card.

DATA PROCESSING, COMPUTING

Data Processing Systems. New 8-page Bulletin 3003A presents maker's "Millisadic" data processing systems. —Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

Circle **689** on inquiry card.

Data Reduction. New 8-page Short Form Catalog C-703 covers maker's full line of analog computers, counters, and newly developed systems for data handling.—Berkeley Div., Beckman Instruments, Inc., Dept. 3950, 2200 Wright Ave., Richmond 3, Calif.

Circle **690** on inquiry card.

Magnetic Tape System. New 24-page Bulletin 1561 B presents maker's "Datatape", new magnetic-tape system for recording stress, pressure, temperature and vibration.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **691** on inquiry card.

Photoelectric Encoder. New 4-page bulletin "Photoelectric Shaft-Position Encoder Type 309-13" presents maker's precision photoelectric analog-digital converter for direct reading of shaft positions to an accuracy of 1 part in 8192.—Electronics Corp. of America, Cambridge, Mass.

Circle **692** on inquiry card.

Converters. New 4-page bulletin presents maker's analog-to-digital converters. Gives application and description.—Norden-Ketay Corp., Wiley St., Milford, Conn.

Circle **693** on inquiry card.

Operations Recorder. New 2-page Bulletin MD-Jr. describes maker's drum type operations recorder and gives physical data and uses.—Gorrell & Gorrell, Haworth, N. J.

Circle **694** on inquiry card.

Data Converter. New 2-sheet bulletin describes maker's data converter that converts magnetic tape to card, tape to printer, and card to tape.—Magnavox Co., Fort Wayne, Ind.

Circle **695** on inquiry card.

Magnetic Tape. New 3-page Bulletin 31 describes effect of coating thickness on frequency response of magnetic tape.—Minn. Mining & Mfg. Co., St. Paul 6, Minn.
Circle **696** on inquiry card.

Recording Oscillograph. New 2-page Bulletin S-313 describes maker's RS-8U recording oscillograph with "greater operational latitude than ever provided in any recording oscillograph."—Houston Technical Laboratories, 2424 Branard, Houston 6, Texas.
Circle **697** on inquiry card.

Decimal Digitizers. New 4-page Bulletin CR-181 gives information concerning maker's three, four, five, and six decade decimal "Digitizers."—Coleman Engineering Co., Inc., 6040 West Jefferson Blvd., Los Angeles 16, Calif.
Circle **698** on inquiry card.

OPTICAL

Micro-Projector. New 4-page Bulletin 2343R describes maker's "Magnascope" for micro-projection to table-top or wall screen.—Victor Animatograph Corp., Davenport, Iowa.
Circle **699** on inquiry card.

ANALYTICAL, LABORATORY

Laboratory Specialties. New 18-page catalog describes maker's laboratory specialties and gives prices and illustrations.—Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.
Circle **700** on inquiry card.

Freeze-Drying. New 36-page catalog features freeze-drying units and accessories, also other laboratory equipment.—Arthur S. LaPine and Co., 6001 S. Knox Ave., Chicago 29, Ill.
Circle **701** on inquiry card.

Laboratory Apparatus. New 16-page Spring Issue of "The Palo Report" describes maker's line of products including scientific instruments and chemicals.—Palo Laboratory Supplies, Inc., 81 Reade St., N. Y. 7, N. Y.
Circle **702** on inquiry card.

Laboratory Glassware. 2 new data sheets in file folder present maker's products, featuring centrifuge tubes.—Doerr Glass Co., Vineland, N. J.
Circle **703** on inquiry card.

Laboratory Gland. New 2-page leaflet describes maker's Teflon laboratory gland which is available in one size 24/40 standard taper and is supplied for either 6mm. or 10mm. shafts or tubing.—Arthur F. Smith Co., Rochester 3, N. Y.
Circle **704** on inquiry card.

Electric Ovens and Furnaces. New 4-page Bulletin 5520 describes maker's laboratory ovens, utility ovens, ultratemp ovens, lab-heat muffle fur-

NEW TEST EQUIPMENT FROM THERMO ELECTRIC

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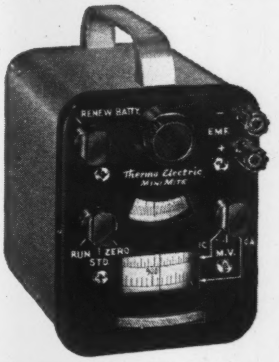

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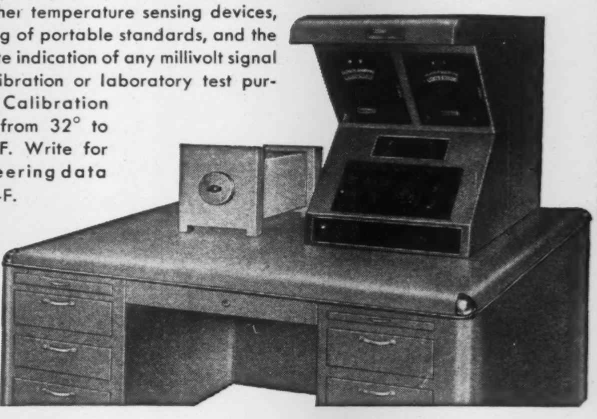

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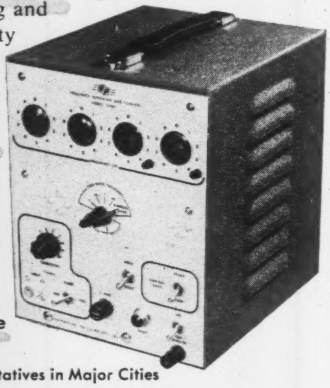

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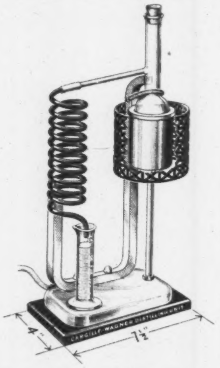

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naces, etc.—Boder Scientific Co., 719-721 Liberty Ave., Pittsburgh 22, Pa.

For more information circle 705 on inquiry card.

Filters. New 2-page Bulletin EL-2 describes maker's cylinder-type filters for laboratories and includes mixers and hand cappers.—Ertel Engineering Corp., Kingston, N. Y.

For more information circle 706 on inquiry card.

Constant Temperature Baths. New 4-page Bulletin 32 presents constant temperature baths with on-off or proportional control providing accuracy of ± 0.001°C.—Bailey Instrument Co., Box 538, Danville, Calif.

For more information circle 707 on inquiry card.

Laboratory Mixers, Pumps. New 2-page Bulletin 1530 presents maker's line of five variable-speed mixers and five motor-driven pumps.—Eastern Industries, Inc., 100 Skiff St., Hamden, Conn.

For more information circle 708 on inquiry card.

Mass Spectrometers. New 16-page Bulletin 1824 B presents maker's process-monitor mass spectrometers. Includes principles and applications. —Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

For more information circle 709 on inquiry card.

Spectrophotometry. New 4-page "Infrared Notes", Vol. 2, No. 2 presents article, "Infrared Spectrophotometry in the Pharmaceutical Industry". Includes bibliography of infrared applications.—Beckman Instruments Inc., Fullerton, Calif.

For more information circle 710 on inquiry card.

Thermal Conductivity Analyzer. New 4-page Bulletin 119 presents specs for maker's thermal conductivity analyzer for gases and single constituents in gas mixtures.—Arnold O. Beckman Inc., 1020 Mission St., S. Pasadena, Calif.

For more information circle 711 on inquiry card.

Gas Chromatography. New 4-page Bulletin 482 presents maker's new gas chromatograph designed for the rapid analysis of gases and low-boiling liquids.—Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

For more information circle 712 on inquiry card.

Argon Gas Purity Analyzer. New 2-page bulletin describes maker's gas cylinder sampling system said to check argon gas to .01% purity.—Thermco Labs., Michigan City, Ind.

For more information circle 713 on inquiry card.

Specific Gravity. New 4-page Bulletin 146 presents maker's line of seven cups for measuring specific gravity and weight-per-gallon of liquids or pastes, and specific gravity of solids.—Gardner Laboratory, Inc., Bethesda 14, Md.

For more information circle 714 on inquiry card.

Spectroscopic Electrodes and Powders. New 16-page Catalog A-400 describes maker's line of 37 special-grade preformed electrodes and includes powders, regular grade electrodes and 12" special electrodes.—National Carbon Co., 30 E. 42 St., New York 17, N. Y.

Circle **715** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Transistorized Voltohmmeter. New 2-page bulletin presents specs and applications for maker's portable, transistorized voltohmmeter with frequency response, as ac voltmeter, from 10 cps to 5 kc.—New London Instrument Co. Inc., 82 Union St., New London 15, Conn.

Circle **716** on inquiry card.

Delay Lines. New 8-page Bulletin 3M556 presents characteristics and tabulates maker's delay lines with total delay from 0.25 to 25 usec.—Brubaker Electronics, Inc., 3652 Eastham Drive, Culver City, Calif.

Circle **717** on inquiry card.

Test Blocks. New 24-page Catalog 1 Sec. 9B describes maker's line of test blocks and switches that facilitate testing and changing of meters and relays.—The States Co., Hartford, Conn.

Circle **718** on inquiry card.

Brushes, Code Discs. New 4-page bulletin presents maker's digital commutators, code discs, choppers, slip rings and brush assemblies.—Electro-Miniatures Corp., 205 Lafayette St., New York 12, N. Y.

Circle **719** on inquiry card.

Electronic Components. New 8-page Bulletin 60 is a distributor's catalog of electronic components, including connectors, transformers, chokes, synchros, condensers, tubes, relays, etc.—Lectronic Research Labs., 715 Arch St., Philadelphia 6, Pa.

Circle **720** on inquiry card.

Millivoltmeter Microammeter Recorder. New 8-page Bulletin MG10 describes maker's millivoltmeter microammeter recorder for low-level direct-current electrical measurements.—Manning, Maxwell & Moore Inc., Industrial Controls, Div., Stratford, Conn.

Circle **721** on inquiry card.

Cathode-Ray Oscillograph. New 4-page bulletin describes maker's low frequency cathode-ray oscillograph with amplitude calibration on both axes, automatic beam brightening on sweeps, and provision for very slow sweep rates.—Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **722** on inquiry card.

Electronic Test Instruments. New 4-page Catalog S-56 describes maker's line of electronic test instrumentation including expanded-scale voltmeters, frequency meters, oscillators and power supplies.—Shasta Div., Beckman Instruments, Inc., Richmond, Calif.

Circle **723** on inquiry card.

Transconductance Analyzer and Circuit Designer. New 4-page bulletin describes maker's transconductance analyzer and circuit designer Model

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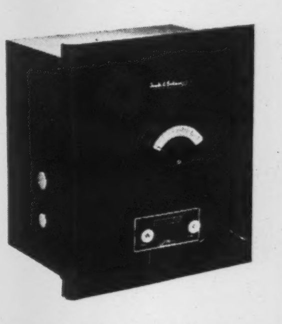

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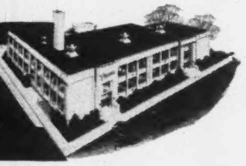
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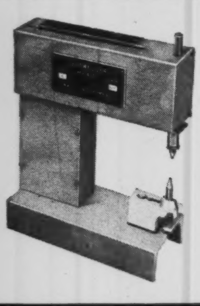

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NEW LITERATURE

901A for use in laboratory, field, product and circuit design.—New London Instrument Co., New London, Conn.

Circle **724** on inquiry card.

Time Delay Generators and Pulse Oscillators. Revised 2-page bulletins on maker's time delay generators and pulse oscillators.—Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Circle **725** on inquiry card.

Induction Modulator. New 6-page folder presents maker's induction modulator designed for conversion of dc current and potential into ac potential proportional to the magnitude of the dc signal.—Weston Electrical Instrument Corp., Newark 5, N. J.

Circle **726** on inquiry card.

Current Amplifier. New 2-page leaflet describes maker's direct coupled, high-frequency-response current amplifier.—Photocon Research Products, 421 N. Foothill Blvd., Pasadena, Calif.

Circle **727** on inquiry card.

Proximity Transducers. New 4-page Bulletin CPP356 presents maker's proximity transducer systems that produce continuous signals from moving metal objects without mechanical contact.—Electro Products Labs., 4501 N. Ravenswood Ave., Chicago 40, Ill.

Circle **728** on inquiry card.

Wattmeters, Voltmeters. New 2-page folder presents maker's astatic wattmeters, voltmeters, and milliammeters for operation up to 1000 cps. Rawson Electrical Instrument Co., 110 Potter St., Cambridge 42, Mass.

Circle **729** on inquiry card.

Master Oscillator. New 4-page Bulletin 173A presents maker's portable master oscillator and heterodyne frequency meter, Model PMO.—Technical Materiel Corp., 700 Fenimore Rd., Mamaroneck, N. Y.

Circle **730** on inquiry card.

Amplifier-Indicator. New 2-page bulletin presents maker's Type 67 carrier-type amplifier-indicator for strain gages, potentiometer pickups, etc.—Crescent Engineering and Research Co., 11632 McBean St., El Monte, Calif.

Circle **731** on inquiry card.

Bridge Amplifier and Meter. New 2-page Bulletin 6 describes maker's transistorized bridge amplifier and meter for strain gage pick-ups and other resistance transducers.—Ellis Associates, Box 77, Pelham, N. Y.

Circle **732** on inquiry card.

Antenna Line Checker. New 4-page bulletin presents maker's instrument specifically designed to check open-end antenna lines.—Century Electronics Co., Inc., 111 Roosevelt Ave., Mineola, N. Y.

Circle **733** on inquiry card.

Variable Frequency Oscillator. New 4-page Bulletin 193 describes maker's variable frequency oscillator, Model PMO-3 which is a precision direct reading device.—Technical Material Corp., 700 Fenimore Rd., Mamaroneck, N. Y.

Circle **734** on inquiry card.

Analyzer. New 2-page bulletin presents maker's new portable analyzer that field-tests Brown "Electronik" continuous-balance amplifiers while installed.—Parameters, Inc., 195 Herricks Road, Garden City Park, New Hyde Park, N. Y.

Circle **735** on inquiry card.

Frequency Meters, Counters. New 6-page folder presents specs for maker's frequency meters, electronic counters, time interval meter and preset counter.—Westport Electric, 149 Lomita St., El Segundo, Calif.

Circle **736** on inquiry card.

POWER SUPPLIES

Regulated DC Power Supplies. New 8-page Bulletin BF 56-1 presents specs and technical data for maker's standard and custom regulated dc power supplies.—Universal Electronics Co., 1720 Twenty-second St., Santa Monica, Calif.

Circle **737** on inquiry card.

Airborne Power Supplies. New leaflet describes maker's high-voltage, airborne, radar dc power supplies with output of 100 microamperes at 6000 volts.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle **738** on inquiry card.

Power Supplies. New 34-page Catalog 56 describes maker's line of regulated and unregulated power supplies with portable, rack and bench type housings.—Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y.

Circle **739** on inquiry card.

Batteries. New 4-page Bulletin 51.-OOA presents maker's batteries for stationary power applications with plastic cases and Silvium positive grid to withstand overcharging.—Dept. TC, Exide Industrial Div., The Electric Storage Battery Co., 42 S. 15 St., Phila. 2, Pa.

Circle **740** on inquiry card.

Miniaturized Power Packs. New 2-page bulletin describes maker's miniaturized power packs for transistor, vacuum tube and standard applications.—Electronic Research Associates, Inc., Nutley, N. J.

Circle **741** on inquiry card.

Power Supplies. New 2-page leaflet presents maker's transistorized regulated dc power supplies.—Electronic Research Associates, Inc., Nutley, N. J.

Circle **742** on inquiry card.

Power Supplies. New 4-page folder describes maker's power supplies used in a variety of radar indicators.—Aircraft Marine Products, Inc., Chemical and Dielectrics Div., 155 Park St., Elizabethtown, Pa.

Circle **743** on inquiry card.

Rotary Power Supplies. New 8-page Catalog 556 describes maker's "Magmotor" maintenance and parts.—Carter Motor Co., 2644 N. Maplewood Ave., Chicago 47, Ill.

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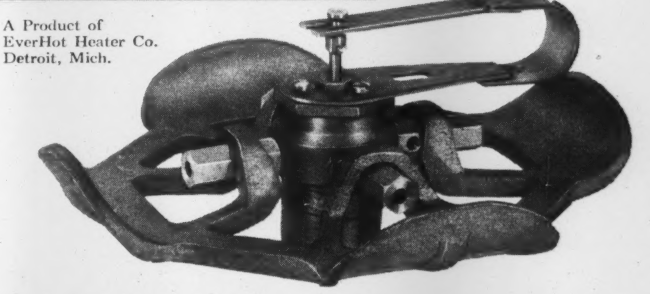

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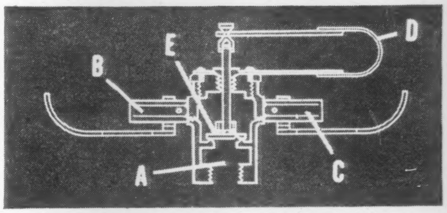

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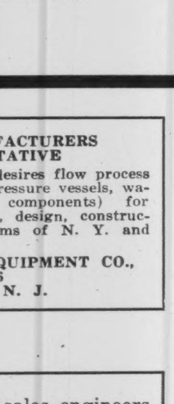

Tensitron, Inc., Harvard, Mass.

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NEW LITERATURE

Power Supplies. New 3-sheet bulletin and price list presents maker's power supply unit, gives specifiications and features.—Deltron Inc., P.O. Box 192, Glenside, Pa.

Circle **745** on inquiry card.

A-C Generators. New 2-page bulletin presents maker's a-c generators available with either belted or direct connected excitation.—Kato Engineering Co., Mankato, Minn.

Circle **746** on inquiry card.

ELECTRONIC COMPONENTS

Display Storage Tube. New 4-page Bulletin P5-LP-JM describes maker's direct-display storage tube that captures and retains transients indefinitely, until intentionally erased from the five-inch screen.—Hughes Products Div., Hughes Aircraft Co., Los Angeles 45, Calif.

Circle **747** on inquiry card.

Resistors. New 4-page "1956-1957 Official Resistor Engineering Guide" gives data on maker's complete line of resistors and special products.—International Resistance Co., 401 North Broad St., Phila. 8, Pa.

Circle **748** on inquiry card.

Resistors. New catalog data Bulletin P-2b describes maker's data on construction, design, applications, ranges, etc. of resistors with axial leads.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle **749** on inquiry card.

New Resistance Alloys. New 4-page Bulletin presents physical and electrical properties for maker's new heating element alloy No. 245 with specific resistance of 830 ohms per cmf. —New 2-page Bulletin presents data on maker's new alloy No. 531 with specific resistance of 1000 ohms per cmf.—Driver-Harris Co., Harrison, N. J.

Circle **750** on inquiry card.

Waveguide Components. New 4-page catalog describes imported waveguide components for use in the 8-10 mm band.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **751** on inquiry card.

Hook-up Wires. New 2-page Bulletin 1901 describes maker's new "Permacode" extruded hook-up wires which provide positive and permanent identification with the color extruded throughout the insulation.—Revere Corp. of America, Wallingford, Connecticut.

Circle **752** on inquiry card.

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Coiled Cords. New 12-page Catalog 556 illustrates applications of maker's "Koiled Kords" that extend to six times their retracted length with from 1 to 37 conductors.—Koiled Kords, Inc., Box K, New Haven 14, Conn.

Circle **753** on inquiry card.

Waveguides and Microwave Components. New 10-sheet folder describes ARA-133 ridge waveguides and coaxial microwave components covering the frequency range from 500 to 11,000 mcs.—Airtron Inc., Linden, N. J.

Circle **754** on inquiry card.

Capacitors. New 6-page folder presents maker's capacitors, including bathtub type, duo-trim adjustable, standard adjustable, tubular and decade type.—U. S. Electronics Development Corp., 1323 Airway, Glendale 1, Calif.

Circle **755** on inquiry card.

Electronic Cable. New 4-page bulletin describes maker's facilities for developing and producing electronic cable with potted connectors and branches and up to 60 conductors.—Pacific Automation Products, Inc., 1000 Air Way, Glendale 1, Calif.

Circle **756** on inquiry card.

Electronic Components. New 4-page catalog includes resistors, rheostats, switches, plugs, dials, capacitors, potentiometers, etc.—Reliance Merchandizing Co., 2223 Arch St., Phila. 3, Pa.

Circel **757** on inquiry card.

Electronic Hardware. New 20-page Catalog 25 describes maker's line of electronic hardware including custom, standard and miniature terminal boards, resistor boards, terminals, stand-offs, connectors, printed circuit hardware, etc.—Lerco Electronics, Inc., 501 S. Varney St., Burbank, Calif.

Circle **758** on inquiry card.

Transformers. New 24-page Catalog S-102 presents maker's TV, radio, communication, and industrial transformers.—Chicago Standard Transformer Corp., 3501 West Addison St., Chicago 18, Ill.

Circle **759** on inquiry card.

Pulse Transformers. New 2-page Leaflet T-36B and T-36S describes maker's pulse transformers with plug-in-mounting, four windings and diagram on each unit.—Berkshire Laboratories, Greenville, N. H.

Circle **760** on inquiry card.

High Temperature Wire. New 4-page brochure presents maker's SW-200 high temperature hook-up and lead wire with silicone rubber insulation for use up to 200°C.—Springfield Wire and Tinsel Co., 70 Leete Street, Springfield 8, Mass.

Circle **761** on inquiry card.

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Silicon Diodes. New 2-page bulletin describes maker's silicon high-conductance junction diodes which are especially designed for circuit appli-

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NEW LITERATURE

cations where high and uniform forward currents and extremely low back currents at elevated temperatures are required.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex.

Circle **762** on inquiry card.

Tubes. New 2-page identification and interchangeability list presents military preferred tube types.—New London Instrument Co. Inc., 82 Union St., New London 15, Conn.

Circle **763** on inquiry card.

Electron Tubes. New 68-page catalog presents specs and characteristics for Ericsson electron tubes—now the only source for important Western Electric types.—State Labs Inc., 649 Broadway, New York 12, N. Y.

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RELAYS, SWITCHES

Stepping Switches. New 12-page Bulletin T5001 presents maker's line of stepping switches. Includes principles and illustrations.—Stromberg-Carlson Co., 100 Carlson Rd., Rochester 3, N. Y.

Circle **765** on inquiry card.

Miniature Switches. New 24-page Catalog 1155 presents maker's "Unimax" precision switches for control and indicating circuits.—Unimax, Div. of W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

Circle **766** on inquiry card.

Key Switches. New 22-page pamphlet describes maker's key switches and lists and illustrates many varieties, including cam and twist type keys.—Stromberg-Carlson Co., 100 Carlson Road, Rochester 3, N. Y.

Circle **767** on inquiry card.

Commutation Switches. New 8-page bulletin presents specs and operating characteristics for maker's commutation switches and commutator plates—Mycalex Electronics Corp., 125 Clifton Blvd., Clifton, N. J.

Circle **768** on inquiry card.

Mercury Plunger Relay. New 2-page bulletin describes maker's midget "Minirelay" mercury plunger relay and provides technical data and illustrations.—Ebert Electronics Corp., 212-31X Jamaica Ave., Queens Village 28, N. Y.

Circle **769** on inquiry card.

Key Switches. New 24-page bulletin presents maker's key switches including indicating, plunger, push and twist button types with locking and interlocking features.—Stromberg-Carlson Co., 100 Carlson Rd., Rochester 3, N. Y.

Circle **770** on inquiry card.

CONNECTORS

Connectors. New 1-page bulletin presents "Series N" connectors with new locked-pin contact and collet clamping device said to eliminate contact discontinuity due to cable pull-out from the connector.—Diamond Div., Cannon Electric Co., 7 N. Ave., Wakefield, Mass.

Circle **771** on inquiry card.

Potting Shells. Two-page bulletin describes maker's potting shells for miniature electrical connectors.—De-Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **772** on inquiry card.

Coaxial Cable, Connectors. New Technical Bulletin 42 presents specs on additions to maker's line of coaxial cable. New 4-page Technical Bulletin 43 is a cross index of maker's line of coaxial connectors. New 2-page Technical Bulletin 44 presents printed circuit receptacles and connectors.—Microdot, Inc., 1826 Fremont Ave., S. Pasadena, Calif.

Circle **773** on inquiry card.

Connectors. New 8-page Catalog 53 presents specs for maker's type AN male receptacles with 422 inserts.—Cal-Connector Co., 7414 Varna Ave., N. Hollywood, Calif.

Circle **774** on inquiry card.

MECHANICAL, ELECTROMECHANICAL COMPONENTS

Electro-mechanical Assemblies. New 16-page Bulletin TDS-1110 presents maker's "Servoboard" assembly kits for building and testing performance of electro-mechanical assemblies for control or guidance systems, analog computer sub-assemblies, instrumentation, servomechanisms, etc. —Servo Corp. of America, New Hyde Park, N. Y.

Circle **775** on inquiry card.

Ball Bearings. New 4-page price list gives prices for maker's miniature ball bearings.—Miniature Precision Bearings, Inc., Keene, N. H.

Circle **776** on inquiry card.

Gear Assemblies. New 4-page Supplement C, Catalog D-64 presents anti-backlash gear assemblies from 1" through 2" pitch diameters.—Dynamic Gear Co., Inc., Amityville, N. Y.

Circle **777** on inquiry card.

Springs. New Folder contains 8-page reprint "Precision Spring Design" paper presented to ASME; new 2-page Bulletin S-1 describing isoelastic spring alloy; three 2-page bulletins presenting model spec sheets for ordering springs. 4-page bulletin discusses spring drift. 4-page bulletin discusses hysteresis. 4-page bulletin discusses straight-line error and permanent set. 4-page bulletin describes application of spring alloy in pressure transmitter with 225°F variance in temperature.—John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.

Circle **778** on inquiry card.

Flexible Shafting. New 12-page Engineering Bulletin 570 is on selecting flexible shafting for power drives and remote control.—Stow Manufacturing Co., Binghamton, N. Y.

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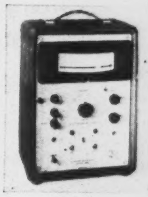

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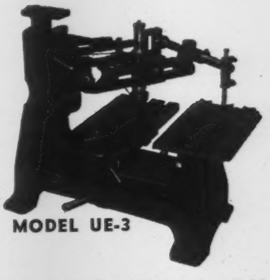

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NEW LITERATURE

Filters. New 12-page Catalog 301 presents maker's Synclinal filters for water; 12-page Catalog 107 presents line of Synclinal filters for oils, coolants and lubricants.—Marvel Engineering Co., 7227 N. Hamlin Ave., Chicago 45, Ill.

Circle **780** on inquiry card.

Stainless Steel Tooling Balls. New 2-page data sheet presents maker's stainless steel tooling balls for reference points in gage, fixture and tool work.—Industrial Tectonics Inc., 3864 Jackson Road, Ann Arbor, Mich.

Circle **781** on inquiry card.

Industrial Tapes. New 4-page bulletin presents maker's industrial tapes for electrical uses—to insulate, hold, splice, identify and protect.—F.O.S. Industrial Tape Div., Seamless Rubber Co., New Haven 3, Conn.

Circle **782** on inquiry card.

Set Screws. New 6-page folder presents maker's "Jewel Case" that contains samples of 18 varieties of set screws and 5 set screw keys.—Set Screw & Mfg. Co., Bartlett, Ill.

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Shafts, Rolls, Guide Rods. New 4-page Bulletin 301 describes 60 case hardened and ground shafts, rolls and guide rods and includes maker's ball bushings for linear motion, Nylon-lined bearings, and multiple-spindle drill heads.—Thomson Industries, Inc., Manhasset, L. I., N. Y.

Circle **784** on inquiry card.

Clutches. New 4-page catalog presents engineering and dimension data on maker's line of miniature, non-reversing clutches said to transmit up to 10 inch-pounds of torque without slippage.—Precision Specialties, 1342 E. 58 St., Kansas City, Mo.

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Bearing Material Selection. New 4-page chart shows chemical, mechanical and work characteristics of a wide range of sintered bronze and iron bearings.—Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.

Circle **786** on inquiry card.

TUBING, FITTINGS

Tubing. New 12-page catalog presents cold drawn mechanical, capillary, hypodermic, nickel and nickel alloy tubing. Data includes comparative analysis of alloy types, specifications, standard tolerances and relative workability.—J. Bishop & Co., Stainless Steel Products Div., Malvern, Pa.

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Industrial Hose and Fittings. New 12-page Bulletin 174 describes maker's industrial hose and fittings and gives order, installation and assembly instructions.—Aeroquip Corp., Jackson, Mich.

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Plastic Pipe. New 4-page reprint announces plastic pipe from "low-pressure" resins said to overcome softening problem at boiling temperatures.—The Danielson Mfg. Co., Danielson, Conn.

Circle **789** on inquiry card.

Self-Flaring Fittings. New 8-page Bulletin 1155-QP presents specs for maker's line of self-flaring fittings available in 8 materials for 5 tubing sizes.—Century Controls Corp., Allen Blvd., Farmingdale, L. I., N. Y.

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NEW LITERATURE

Thin-Wall Tubing. New 5-page Data Memorandum No. 4 describes maker's large-diameter thin-wall tubing available in 24 material specs.—Superior Tube Co., 1564 Germantown Ave., Norristown, Pa.

Circle **807** on inquiry card.

MATERIALS

Beryllium Copper. New 8-page bulletin describes heat treatment of beryllium copper wrought and casting alloys, including temperature charts and data on physical properties. New 2-page bulletin describes use of beryllium copper contacts for printed circuits.—The Beryllium Corp., Reading, Pa.

Circle **791** on inquiry card.

Teflon Products. New 12-page brochure on maker's products fabricated from DuPont "Teflon" gives applications for which it can be fabricated.—Crane Packing Co., 6400 Oakton St., Morton Grove, Ill.

Circle **792** on inquiry card.

Component Cleaner. New 8-page booklet describes technique used in cleaning precision components such as transistors, diodes, vacuum tubes, jewel bearings etc.—Cobehn, Inc. Caldwell, N. J.

Circle **793** on inquiry card.

Plastics. New 4-page bulletin describes maker's plastics design and development service, process and products.—Allegheny Plastics, Inc., Route 51 and Thorn Run Road, Coraopolis, Pa.

Circle **794** on inquiry card.

Ferromagnetic Plastics. New set of bulletins describes maker's "Ferrotron" ferromagnetic plastic materials, both in flexible rod and tape, and rigid powdered iron cores.—Polypenco, Inc., 2150 Fairmont Ave., Reading, Pa.

Circle **795** on inquiry card.

FABRICATION

Drafting. New 56-page Bulletin AMF 112-6 includes 44 pages of details on traditional and simplified drafting practices.—American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y.

Circle **796** on inquiry card.

Industrial Benches. New 4-page Bulletin 516 presents maker's "Product-A Flow", an expandable bench system. Includes price list.—Products For Industry, 49 Washington Ave., Stamford, Conn.

Circle **797** on inquiry card.

Leather Cases. New 4-page Bulletin 601 illustrates maker's leather cases for instruments, radios, photographic and military equipment.—Graton & Knight Co., Worcester, Mass.

Circle **798** on inquiry card.

Special Hand Tools. New 8-page bulletin presents maker's "Mini-Tools"—polished probes and wedges for miniature assembly.—Wen[illegible]on Co., 17 Irving Ave., Stamford, Conn.

Circle **799** on inquiry card.

Engineering Services. New 4-page bulletin describes research and development facilities in electronics. New 4-page bulletin describes field engineering services for military and industrial electronic equipment.—National Scientific Labs., Inc., 2[illegible]10 Mass. Ave., N.W., Washington 6, D.C.

Circle **800** on inquiry card.

Work Bench. New 4-page bulletin features maker's "Rolla-Bench", rolling work-bench extension that provides 5 sq feet extra working space and includes 2 direct drive and 2 gear drive laboratory stirrers.—Palo Laboratory Supplies, Inc., 81 Reade Street, New York 7, N. Y.

Circle **801** on inquiry card.

Molded Pulp Packaging. New 6-page Bulletin B101-5 illustrates applications of molded pulp "Fibre Form" system for packaging fragile products.—Arvey Corp., Fibre Forming Div., Olean, N. Y.

Circle **802** on inquiry card.

Barrel Finishing. New 6-page Bulletin F.9339R1 describes barrel finishing operations and presents materials for pre-cleaning, cutting down, descaling, burnishing and rinsing.—Oakite Products, Inc., 154 Rector St., New York 6, N. Y.

Circle **803** on inquiry card.

Gas Producers. New 8-page Bulletin GEC-1375 gives pricing data, product features, dimensions and application data on maker's Neutralene gas producers which produce purified exothermic gas for protective-atmosphere heat treating.—General Electric Co., Schenectady 5, N. Y.

Circle **804** on inquiry card.

Gear Remover. New 2-page leaflet describes maker's infra red (heat expansion) HCL gear-remover for removing parts attached to axles or shafts. Gives theory of operation and specifications.—Miskella Infra-Red Co., East 73rd and Grand Ave., Cleveland 4, Ohio.

Circle **805** on inquiry card.

Plating Process. New 10-page brochure describes "Lectro Nic" the maker's plating process for depositing hard, ductile, compressively-stressed nickel coatings.—Sel-Rex Precious Metals, Inc., 229 Main St., Belleville 9, N. J.

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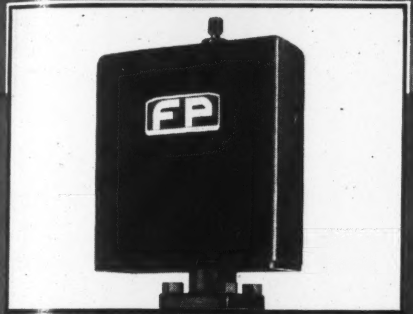

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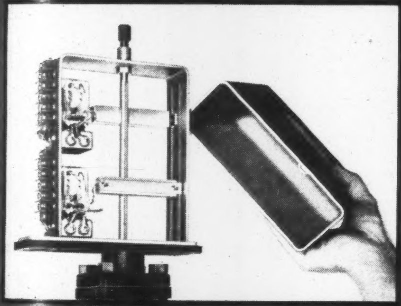
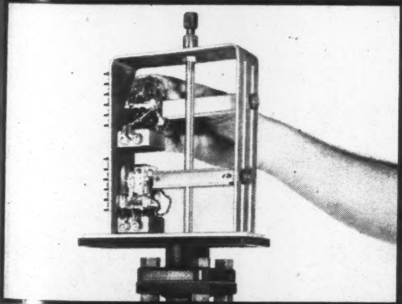
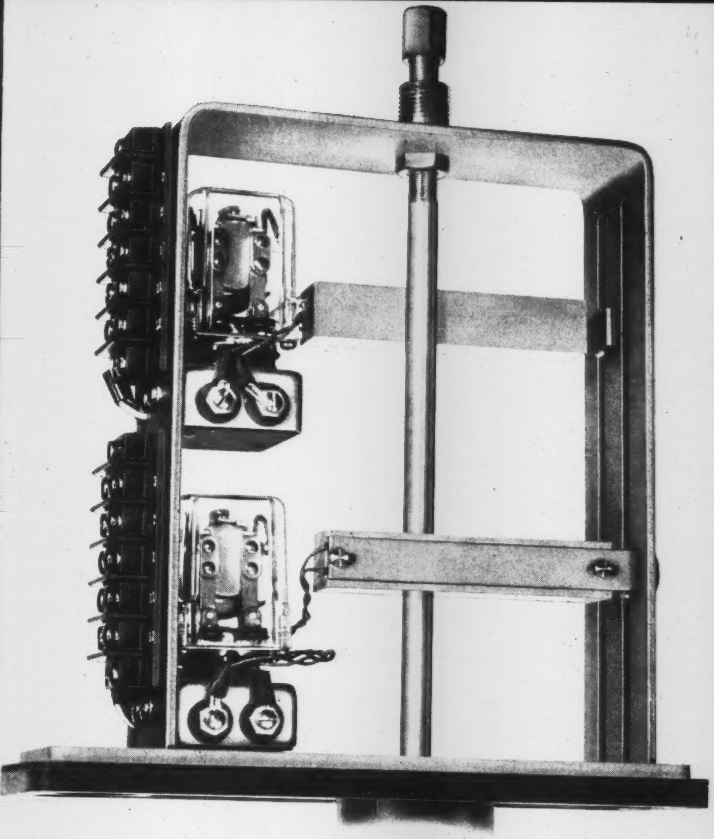


Ratolarm with cover removed



Relays are easily replaced



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